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CONTENTS

DIESEL RAILWAY TRACTION

A Supplement illustrating and describing developments in Diesel Railway Traction is presented with each copy of this week's issue.

"Railwayfication" of the Roads

AMONG people who never use the railways because they own an automobile there existed at one time many who sincerely believed that the train was becoming obsolete, and that in the not very distant future the steel tracks would be torn up to make room for concrete surface automobile speedways. When there were only three or four automobiles per mile of roadway, it was easy for the motorist to believe in the superiority of his system, but now, with ton-mileage figures on the road approaching those on the railways, it is harder to find the advantage, or indeed to see any marked difference. The one-way street, the colour-light signal, driving tests, car parks or sidings, and the ban on overtaking in built-up areas (actually the new 30 m.p.h. limit amounts to this) are making the roads resemble railways ever more closely. Because motorists proceeding head to tail for miles in single file would be happier if strung together and piloted along by the head man, it wants but one bright person more interested in scenery than in another motorists's tail lamp to suggest this and the transformation will be complete—the railway system will have been invented again by the very people who affected to despise it.

The Value of Railways to Industry

The ability of road hauliers to select the traffic they find most remunerative and leave the rest to the railways may benefit individual operators, but it is not in the interests of the community as a whole. Essential transport services must be carried on, and at present the companies have to shoulder them under uneconomic conditions. Mr. W. V. Wood, in a speech to the Imperial Industries Club, briefly recorded in a news paragraph last week, suggested that this state of affairs must result in a reduction of railway rates for the higher grades of traffic, which would make imperative a modification of the rating structure if the companies were to continue providing adequate facilities. Alternatively, road operators would have to be subjected to the same restrictions as are now imposed on the railways. Mr. Wood disposed of the argument that the railways do not need consideration because they are obsolete by remarking that the roads could not carry the traffic now handled by train even were they multiplied half a dozen times. It would be impracticable to enlarge them sufficiently to carry the traffic in coal alone. Industry could hold its own with foreign competitors only if provided with the cheapest possible transport, and it was unreasonable to expect that while railway overheads amounted to seventy per cent. of their receipts. Mr. Wood's paper is summarised in our news section this week.

* * * *

London Transport "C" Stock

Last year the London Passenger Transport Board obtained powers from Parliament under its Interim Financial Arrangements Act to vary the precise terms of the Act of 1933 so as to enable interim payments to be made on Transport "C" stock before completion of the annual accounts for the year ended June 30, 1934. There was no hope of the pooling scheme with the main line companies being settled before June 30, and it was considered unlikely that the compensation payable to all the independent omnibus undertakings acquired could be ascertained by that date. The pooling scheme has now been agreed, but it is unlikely that the considerations for all the undertakings transferred to the board will have been determined by the tribunal before the end of the second financial year of the board—June 30, 1935. In order to avoid again postponing the publication of the accounts, the board is applying for leave to introduce additional clauses in the London Passenger Transport Bill now before Parliament which, if passed, will enable the board in effect to close its accounts in respect of each financial year on the basis of setting aside out of the revenue for each year to an interest suspense account for such year such a sum as the board may deem adequate to meet obligations not determined by the tribunal in respect of transferred undertakings. The additional clauses will also provide for payment of interest on "C" stock within three months—or such extended period as the Minister of Transport may allow—after the end of each financial year.

* * * *

Railway Accident Insurance Claims

Some of the problems which face an insurance company's loss assessor after a railway accident were discussed in a recent issue of *The Manchester Guardian Commercial*. Where passengers are concerned, an interesting point is the number of times their names are liable to appear in different claim files, owing to the fact that the various companies by whom they are covered either personally, as newspaper readers, or as employees of a firm, may be themselves reinsured against their obligations exceeding a certain amount. The King's Langley goods train collisions of March 13 on the L.M.S.R. raised some curious

points. A poultry farmer claimed on a fire insurance policy for the destruction of an incubator by a van which had caught fire after falling down the embankment, but the insurance company contended that his property had been shattered and rendered useless before it was set alight, and that they were therefore not liable for his loss. The conveyance of motorcars by rail suggests another insurance problem in case of accident—namely, whether damage received in transit is covered by an "accidental impact" clause normally applying to road collisions. Much, it seems, depends upon the acumen of the party stating the claim, and a good example is the passenger whose luggage was burned and who claimed under a comprehensive household policy on the grounds that he had lost household goods "in course of removal."

* * * *

"International" Traffic Extraordinary

Between 12.0 o'clock and 2.0 o'clock on Saturday, April 6, the L.M.S. booking offices at Glasgow Central issued 27,000 tickets for one station. That station was Mount Florida on the Cathcart Circle line, and the travellers were football enthusiasts bound for the England v. Scotland match at Hampden Park. The traffic handled was 4,000 in excess of Glasgow's previous highest record on any occasion. The issue of ordinary and cheap day tickets from Glasgow to Mount Florida was suspended between 12.30 and 3 p.m., and a special return fare of 6d. was instituted (the usual fare is 3d.). The number of people who presented themselves at the station, however, greatly exceeded all expectations, and by 1.0 p.m. the spacious circulating area was so thronged that incoming passengers could not reach the exits because of the tightly packed mass of intending passengers. The more unruly portions of the crowd clambered over the ticket barriers, laid hold of the carriages in any platform, and demanded to be taken to Hampden, whether the train was advertised to go there or not. The issue of ordinary and cheap day tickets was again suspended between 4.30 and 6.0 p.m., when the returning crowds were due, and only single journey tickets (price 3d.) were issued during that period from Cathcart Circle stations to Glasgow.

* * * *

A Careless Gateman

The serious results which may come of carelessness in exchanging telephone messages have again been emphasised by an accident on the German State Railway, reported in our contemporary *Der Eisenbahnfachmann*. A work train had to proceed on the wrong line—the left hand line in Germany—as far as an intermediate block box, where it was to unload materials and return. There were four level crossings to be passed on the way, guarded by lifting type barriers worked by watchmen and provided with the usual large signal gongs seen on the Continent. When the train had finished unloading, the signalman advised all the gatemen by telephone one minute before its departure that it would leave at 8.40, which it did. The weather was foggy and visibility was limited to about 165 yd. The gateman at the third crossing from the box thought the departure time was given to him as 8.45 and appears to have repeated it, if at all, so indistinctly that his error passed unnoticed, while he neglected to make any entry in his telephone message book. About this time an ordinary passenger train passed through the section in the regular way on the other line and the gateman, miscalculating the probable time of arrival of the work train on the basis of his original mistake, at once allowed a horse drawn vehicle to cross behind it. Before it was over, however, the work train appeared suddenly out of the mist and ran it down, fatally injuring the driver and a pedestrian. Even though he believed he knew the time correctly, the gateman ought to have been doubly careful when fog prevailed and should have enquired of the adjacent crossings if they knew where the work train was.

* * * *

C. and D. Service on the Pennsylvania Railroad

Since the Pennsylvania Railroad of the U.S.A. instituted its collection and delivery freight service in December, 1933, the volume of traffic handled under this system has increased almost continuously. The result has been to assist in improving the company's business in less-than-carload consignments by increasing the average load per car of freight of this kind by about fifty per cent., with a beneficial effect upon economy of operation. Last year, for the first time since 1925, less-than-carload traffic showed an increase, and 17½ per cent. of the total value was contributed by the 2,643,510 consignments handled by the collection and delivery service. When general freight movement reached its peak in October last, this traffic amounted to over 300,000 consignments, or 21 per cent. of the less-than-carload business, and in the two succeeding months the proportion increased to over 22 per cent. An indication of how appreciation of collection and delivery facilities has increased is afforded by comparing these figures with those for the first month during which they were available. At that time less than 49,000 consignments, or 5½ per cent. of less-than-carload traffic, were dealt with.

* * * *

Signalling in Roumania

Until a few years ago signalling on the Roumanian Railways may be said to have been practically non-existent, for there were only a few installations of interlocking apparatus, of the Schnabel and Henning, Jüdel, or Siemens and Halske types, scattered about the system; since 1929, however, an extensive programme of new work has been put in hand. A certain amount of apparatus has been received on reparations account, but the greater part of it has been provided out of an international loan of 195,000,000 lei (about £240,000 at par) raised for this purpose. Up to October last, 40 new installations had been put in, bringing the total of fully interlocked stations up to 213. That at Bucharest North, described in our issue of June 23, 1933, is on the latest all-electric system, with track and route locking. A simplified system for small stations, consisting of station block apparatus and hand worked points, bolted from a central point, has been supplied to 242 places, and now all the principal routes may be said to possess satisfactory signalling. Seventeen installations are in hand, including automatic block signalling on 30 km. (18·75 miles). Much remains to be done, however, for of the 1,011 stations on the system, less than half are signalled as yet. Plans for further work, to cost 700,000,000 lei (about £872,000) have been prepared and will be carried out as funds permit. They cover 81 new and 5 re-modelled installations, including the hump yard at Ploesti, and the use of automatic colour-light signalling on 150 km. (93 miles) of double line where the heaviest traffic is met with.

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The Dotsero Cut-off

The much improved connections with the Pacific coast of the United States which the Denver & Rio Grande Western Railroad now possesses by virtue of the Dotsero cut-off were described in our issue of June 8 last. By the opening of the new line on June 16, 1934, the company realised an ambition to open up a route directly westward from Denver to the sea which had existed since

construction of the circuitous route *via* Pueblo was started in 1871. An account of the steps which led to the achievement of this aim appears in the January issue of the American periodical *Baldwin Locomotives*. It was not until 1890 that the D. & R. G. (as it then was) completed a route from Denver and Pueblo to Salt Lake City by opening a line through the Continental Divide at Tennessee Pass, which connected with the Rio Grande Western system. Early in the next century the Denver & Salt Lake Railway struck out westward from Denver over the Corona Pass, but failed for financial reasons to reach its objective. In 1922 a state bond issue was authorised by the Colorado legislature to improve this route by piercing a tunnel through the mountain barrier, and in 1927 the Moffat Tunnel was compieted at a cost of nearly $18,000,000. The Dotsero cut-off, costing some $3,750,000, justified the public's expenditure by connecting the unfinished D. & S. L. line with the existing route to the west coast.

* * * *

Large or Small Freight Cars?

In view of the suggestion, to which we drew attention some time ago in referring to an experimental 4-wheeled freight car built for service on the U.S.A. railways, that freight cars smaller than the normal double-bogie type should be used, the comments of Mr. V. R. Hawthorne, Secretary of the A.R.A., Mechanical Division, are worth noting. In a paper entitled "The Freight Car," abstracted in the *Railway Age*, he pointed out that the small car would probably cost more and be more expensive to operate on a tonnage capacity basis than the conventional type, since, except in special cases, it must be handled in regular freight train service and must therefore be built strong enough for that purpose. As a result it would be difficult to build an effective and safe vehicle without a very high ratio of dead weight to load carrying capacity. Further, much of the present day small consignment traffic, which a small car is specially calculated to handle economically, may be purely temporary. As the service life of a freight car in the U.S.A. is 20 years or more it would not be practical to change the size of freight cars unless there was more than a temporary demand. Otherwise the required investment in such special equipment would not be warranted. A well known British railway authority with whom we have discussed the matter holds that the best design of freight vehicle should be based on the principle of a high capacity flat truck with containers having doors facing the side. In this way the whole container truck might be used as an ordinary wagon for smaller consignments when not required otherwise.

* * * *

The Optimum Superheat Temperature

Despite the world-wide use of superheaters there is still a divergence of opinion regarding the most favourable ultimate temperature for the steam. Some engineers believe that the useful limit is reached when the losses due to cylinder condensation have been overcome, while others favour the highest degree of superheat which can be attained without introducing serious practical difficulties. How this difference of opinion came to arise is made evident by an article we publish elsewhere in this issue, dealing with the experiences of Professors Lomonossoff, Nordmann and other distinguished investigators. Superheated steam flows through restricted openings more readily than saturated steam, so that the higher the temperature used the smaller are the wiredrawing and back-pressure effects and the greater is the useful work performed for a given heat expenditure. In modern engines advantage can be taken of the increased fluidity of the steam, and hence a high degree of superheat appears preferable to a moderate degree. But increased fluidity acts adversely on leakage and in older engines the losses due to leakage increase with the superheat temperature faster than the gains corresponding to a fuller indicator diagram. Thus with many engines still in use there is a definite limit to the gains which can be achieved by superheating, and this limit appears to be reached at or about the temperature where cylinder condensation is overcome. It is now easy to see how there came to be two such divergent opinions on this matter of the optimum superheat temperature.

* * * *

The B.E.S.A. Bull Head Rail Specification

For some time past the need has been urged for a further revision of the British Standard rail specifications, in order that recognition may be given to the medium manganese analyses which are now in such general use. This revision, in so far as it applies to bull headed rails, has now been published, and is reviewed on page 729 of this issue. We are glad to see that the revisers have legislated for the future as well as the present by extending the manganese limits of 0·90-1·10 per cent. to 0·90-1·20 per cent., which will give greater latitude in regard to this important element. In the higher carbon analyses, also, the permissible manganese maximum is raised from 0·8 to 0·9 per cent. In the basic open-hearth process the narrow limit of phosphorus is relaxed by an increase from 0·04 to 0·05 per cent. with both sets of analyses, which gives greater freedom to the manufacturer without risk to the user; indeed, within strict safety limits, phosphorus is a valuable wear constituent. We are also pleased to see effect given to another point that we have stressed, in that, with medium manganese rails, no upper tonnage limit is set to the breaking strength of the steel in the tensile test, which may, with advantage to the user, be as high as possible, granted that the specified minimum of extension is duly obtained. In view of the reviving interest in the 100 lb. bull-head, it is a pity that opportunity was not taken in this revision to alter it to conform in the web and foot to the 95 lb. section, in order to permit 100 lb. re-railing in 95 lb. chairs.

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Cylinder Height in Locomotive Design

While it is usual to keep the centre line of cylinders at the same height above rail level as that of the driving axle, this is not always done, especially with outside cylinders, nor is it essential, provided the height between the cylinder and crank axle axes is not more than about 4 in. Greater differences than this necessitates the inclination of the cylinders, which, however, is not always a desirable arrangement. In America engines may be found with cylinder centres as high as 4 in. above the crank axle centre, and the 2-6-0 and 2-8-0 mixed traffic engines of the G.W.R. are examples in which the centre lines are 2 in. or 3 in. apart. It is always desirable, especially in the case of engines having small wheels, to keep the cylinders as high above rail level as possible, not only so that the cylinder casing may be compact and near to the smokebox, but to provide as much room as possible for the leading carrying wheels and also to provide the maximum clearance between the cylinders and structures adjacent to the rails. Sometimes there may be no reason apparent for the difference in relative height above rail level, the actual reason being that the same cylinder pattern as that used in another class of engine may be adopted in order to minimise not only pattern making but the stock of spare cylinders.

Paris-Orleans and Midi Reports for 1934

DURING the past week or two the annual general meetings of two of the more important French railway companies have taken place. In the report of the Paris-Orleans Railway for 1934, presented to shareholders at the meeting on March 29, the chief operating results compare as follows with 1933:—

	1934	1933
Total receipts	fr. 1,500,693,584	fr. 1,664,310,223
Total expenditure	1,333,828,486	1,528,703,707
Net operating income ..	166,865,098	135,606,516

These are the results of the Paris-Orleans Company alone, and the joint operation of the Paris-Orleans-Midi lines for the year shows total receipts as 2,249,105,676 fr. and expenditure 2,069,812,989 fr. The operating ratio of the joint system is 92·03 per cent. against 97·36 per cent. in 1933. In 1933 the operating ratio of the Paris-Orleans alone was 91·85, which was for the fourth consecutive year the best ratio in France. M. Richemond, President of the Paris-Orleans directorate, in his address to shareholders, pointed out that the traffic receipts of the joint Paris-Orleans-Midi lines had decreased 3·02 per cent. in comparison with those of 1933, a decrease that would have been 6·62 per cent. but for the fact that the lines had benefited by the reduction of the passenger tax in November, 1933, this being tantamount to an increase in fares. Fast goods receipts, which represent 56 per cent. of the total, had declined 8·70 per cent., and the number of passengers decreased 8·76 per cent. Decreased receipts, added the President, were due to the trade depression, which affected agriculture as well as industry. In addition, certain reductions in freight rates had been imposed on the companies by the Government. On the other hand, the expenditure of the P.O.-Midi systems had diminished by fr. 185 million in comparison with 1933. Part of this decrease was due to the reductions in wages and pensions, which came into force in April, 1934. After some remarks on the rail and road co-ordination plans, M. Richemond said that there had been a noticeable reversion of public opinion in favour of the railway in the past year. This was due to the efforts of the railways to modify their commercial methods within the limit allowed by the regulations, which had not kept pace with the times. Measures had been taken in the joint working of the P.O.-Midi lines to develop commercial services, and particularly good results had been obtained between Orleans and Tours with retail goods transport and delivery to any address from the district central stations.

The report points out that, despite the decline in general railway traffic, there had been an increase in the traffic by electric traction due to the opening of the electric service between Orleans and Tours. The electric traffic amounted in 1934 to 11,216,293 train-kilometres and 6,065,701,300 tonnes-kilometres, against 10,171,966 train-kilometres and 5,481,315,500 tonnes-kilometres in 1933. The consumption of electric power amounted to 160 million kWh. against 130 millions, the power produced at the Eguzon hydro-electric works was 74 million kWh., against 62 millions and at the Coindre works 84 millions against 75 in 1933. Electrification of the line from Vierzon to Brive was pushed forward in 1934 with the intention of opening the line for electric traffic in the middle of May. The dam at Marèges was almost completed and the hydro-electric works would probably be in operation next July. On the Midi system, the line from Bordeaux to Pointe-de-Grave at the mouth of the Gironde had been opened for electric traffic. Electrification of the line from Montauban to Sète, the Mediterranean port, was proceeding rapidly and the section from Narbonne to Sète would be opened in July, while the whole line was likely to be ready for electric traction toward the end of the year. The report further records that at the present time the electrified lines of the Midi system totalled approximately 1,000 miles, comprising nearly 400 miles of double track. This year's extensions would add about 170 miles to the total and the electrified sections would then represent almost 45 per cent. of the entire system.

In presenting the annual report for 1934 to the shareholders' meeting on April 2, M. Paul Tirard, President of the Midi Company, delivered a speech which makes very depressing reading. He stated that the operating receipts amounted to 748,412,091 fr. and the operating expenditure to 735,984,503 fr. But taking into account the deficits of subsidiaries and all charges, the expenditure totalled 1,089,986,086 fr., leaving a total deficit of 341,573,995 fr. to be met by the Common Fund of the French railways. M. Tirard added that the receipts of the P.O.-Midi lines had decreased to an unexpected extent during 1934 and the decline had been intensified since the beginning of the current year. This was due to the trade depression affecting the whole country. The industrial and mining output had decreased, numerous metal-producing mines having ceased operations. Agriculture had also been hard hit.

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Recipes for Recovery

THE French transport industry represents an investment of fr. 150 milliards, and in its three branches of railways, waterways and roads employs 1,500,000 persons and turns over fr. 23 milliards annually. M. Raoul Dautry, General Manager of the French State Railways, emphasised in a recent address (reported in *La Vie Financière*) that these enterprises are fundamental elements in the economic life of the country, but showed how the depression is in every case causing the potentialities of the money and man power which have been absorbed into them to stagnate. France has invested over fr. 10 milliards in her 5,750 km. of canals and 7,000 km. of navigable rivers, and when to this sum is added the value of the vessels employed thereon, the total exceeds fr. 12 milliards. The industry employs 48,000 persons directly but, including workers' families, 60,000 are dependent upon it for their subsistence. As a result of falling traffic, however, most of the river transport companies have ceased to pay dividends, and the men who run their own boats earn scarcely enough to support themselves. The more fortunate work, on an average, about 160 days a year, but many are idle for 300 days.

Next in age to rivers and canals as a transport medium come the roads, wherein quite fr. 55 milliards are invested today, including the post-war expenditure on reconstruction. Motorcar factories, kindred industries, stores and repair-shops together represent fr. 11 milliards, and petrol services fr. 3 milliards. There are 1,900,000 vehicles in use, of which 1,400,000 (1,330,000 private and 70,000 public) carry passengers, and their combined value is fr. 16 milliards. Goods transport employs 500,000 vehicles, of which 40,000 provide public services. The annual turnover of the road transport industry is about fr. 12 milliards. Even so, many of the companies are in difficulties because the services they should produce for the money invested in them exceed the demand.

The capital invested in the French railways amounts to over fr. 1·593 a head of the population, each unit of which travels on an average 585 km. yearly and requires the carriage of 762 tonnes of goods for his requirements. Upon the provision of these facilities, 511,000 persons were employed three years ago; today the number is only

429,000. In normal times there are 415,000 occupied in the construction of rolling stock and associated industries. In concluding, M. Dautry emphasised the regularity, safety speed and economy of the railways, and urged the necessity of co-ordinating the interests of the three means of transport with which he had dealt. In other words, he accepted the fact that the shrinking demands of today are unable to keep all three employed to capacity, so that there is often ruinous competition to secure as much of the business offering as possible. M. Dautry's solution is to infuse decorum into the scramble by imposing restrictions as to what each competitor may offer to do.

But to reduce facilities to accord with the existing attenuated demand, even though M. Dautry advocates it in the distinguished company of the French Prime Minister himself, will turn out not to be a solution at all. If a realist view be taken of the situation, it will be seen that there is no justification for a reduction in the wealth of France. No earthquake or fire, no violence of nature or of man, has occurred to account for this shrinkage which M. Dautry describes. The trouble is an abstract one and soluble financially, but only if money is looked upon, not as if it were a marketable commodity, but as if its sole purpose were to distribute to would-be consumers the goods and services industry makes available.

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Argentine Pensions

AFTER many vicissitudes the Argentine National Railway Pension (Amendment) Bill has now reached a further stage. The alterations to it proposed by the Senate have been accepted and passed by the Chamber of Deputies, which failed to obtain the two-thirds majority required to over-rule the Senate's amendments. From the viewpoint of British-born and other foreign railway employees, the most important of the Senate's modifications is the removal of the " residence " clause, which aroused such a storm of justifiable protest among foreign-born employees on all the railways. As the Senate has now twice rejected this obnoxious feature of the bill, there would seem to be good grounds for hoping that it has been finally disposed of, thus securing to all foreign railway employees the right to reside in their native lands after retirement without forfeiting their pensions.

The principal modifications to the law relate to the granting of invalid pensions and the amount of the monthly contributions, which have been raised from 5 to 6 per cent.: this, it is estimated, will bring in an additional $2,800,000 paper per annum. The Deputies' amendment provided that the monthly contributions should be based on the amount of the salaries. Under the amended law, invalid pensions will be granted only after 10 years' service, and are to be calculated on the basis of 5 per cent. of the ordinary pension for each year of service up to the maximum, instead of 10 per cent., as hitherto, an excessively liberal allowance which has been greatly abused and is largely responsible for depleting the resources of the fund. In the case of pensions already granted for less than 10 years' service, an equivalent annual rate, based on the amended law, will be fixed according to the number of years of service.

Under the amended regulations, pensions paid to the unmarried daughters of deceased employees will cease at the age of 22, except when the beneficiaries are physically incapacitated from earning a livelihood. During the period required for the adjustment of the benefits at present in force, the old rates will continue to be paid, but any sums disbursed in this way in excess of the new scale of payments will have to be refunded in not more than 10 monthly instalments. The foregoing reforms fall very far short, however, of the recommendations made by the Government committee which was appointed to study the question, and subsequently embodied in the proposals of the Chamber of Deputies, and the preamble to the decree legalising the new Bill makes it clear that the modifications in it are provisional until such time as Congress is possessed of sufficient information to enable a comprehensive scheme to be drafted for putting the fund on a permanently solvent basis.

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An Epic Locomotive Performance

AMONG the many remarkable runs which have been recorded in the pages of THE RAILWAY GAZETTE during the past twelve months, none has given more convincing proof of the power capacity of the modern steam locomotive than that made by one of the rebuilt P.O.-Midi 4-8-0 engines (described in THE RAILWAY GAZETTE of July 14, 1933, page 48), when running on the Nord main line between Calais and Paris on February 19, as detailed elsewhere in this issue. The occasion being a trial trip, the new dynamometer car of the O.C.E.M. was attached, and by the kindness of M. Lancrenon, Chief Mechanical Engineer of the Nord, we are able to reproduce the record taken on this vehicle. In the realms of acceleration, hill climbing, and sheer speed along the level with a train weighing no less than 635 tons behind the tender, this eight-coupled compound locomotive, with 6 ft. wheels, showed phenomenal characteristics. The fast start out of Calais Maritime was followed by a magnificent climb up the long 1 in 125 gradient to Caffiers, with a minimum speed of 51 m.p.h., and, later, by an average of 79·7 m.p.h. over 46 consecutive miles, with a rising tendency of approximately 1 in 800-1,000 against the engine. The power output peaks occurred at Caffiers and Neufchatel summits, drawbar horsepowers of 3,000 and 2,930 respectively being recorded at these places.

The exceptionally free exhaust passages from the cylinders to the atmosphere are responsible largely for the free running of this eight-coupled design, which makes for a close approach to the ideal of an express engine, capable of the highest speeds in conjunction with extraordinarily rapid acceleration. A study of the details, especially of the second section of the run, will indicate how striking has been the success in this direction achieved by M. Chapelon, the designer of this locomotive. After a classic start from Amiens, when the 810-ton train (including the engine) was accelerated to 62 m.p.h. in 4½ min. and a long pull at high speed up to Gannes, a maximum of 89·5 m.p.h. was reached on the descent to Creil. Then, following another climb—to Survilliers—90 m.p.h. was topped on the subsequent descent. The coal consumption of 89 lb. a mile was by no means heavy, considering the weight of the train, the speed and the gradients. Moreover, the firing rate of 145 lb. per sq. ft. of grate per hour did not prove to be beyond the capacity of the fireman, aided by a shaking grate, over a period of nearly three hours. The same 4-8-0 engine had been tested previously on 745-ton fast stopping trains between Paris and Boulogne, and has since undergone high-speed trials between Paris and Cherbourg (on the Etat) with 635-ton trains. All these tests have fully confirmed the remarkable results obtained on the Vierzon-Toulouse and Tours-Bordeaux lines of the owning company, with trains up to 800 tons weight on 56 m.p.h. bookings, and up to 575 tons on 70 m.p.h. schedules, of which we have recorded examples in previous issues.

LETTERS TO THE EDITOR

(The Editor is not responsible for the opinions of correspondents)

High Speed Steadiness

Chinthurst Lodge, Wonersh,
Guildford, April 8

TO THE EDITOR OF THE RAILWAY GAZETTE

SIR,—I should like to thank Mr. Bell for his letter, as it throws light on the subject. I still think that what I said about the instantaneous velocity is mathematically correct. The effect of forward motion and a transverse velocity at any given moment is a compound one. But it is now clear that the two effects which I suggested are not a sufficient explanation, although probably contributory, since both of them would come into play gradually, whereas the problem is evidently connected in some way with resonance. At the moment I have nothing further to add.

Yours faithfully,

C. F. DENDY MARSHALL

Improving Branch Line Services

Leeds, April 2

TO THE EDITOR OF THE RAILWAY GAZETTE

SIR,—In regard to the recent correspondence on train accelerations, it is very satisfactory to see that the English railway companies are at last beginning to appreciate the value of really fast express passenger and goods services both from the advertisement and the practical points of view, though even now the general trend appears to be, at least with passenger services, more in the direction of accelerating a comparatively few selected trains than a general raising of the average speed.

There is, however, another direction which receives very little attention, namely the speed of local and branch services. Although fast expresses attract and carry a large number of passengers, the main support of passenger traffic must lie in the local services, from people travelling in to their market towns and from town dwellers going out into the surrounding country. Yet a study of the timetables shows in the vast majority of cases that the running times have scarcely been altered for, I might almost say, generations, with the result that the trains amble along nearly empty at twenty or less miles an hour, and still leave plenty of time for the train staff to talk over all the local gossip at each station while "making up" time. A case I have in mind particularly is a branch running from one market town to a junction with another branch five miles from a second market town. Yet, in spite of strong road competition, the average speed still remains at 17 m.p.h., and not even on market days are through trains run to the second market town. On this branch, too, one train has for years been carefully timed to leave, to suit crossing arrangements at a station adjacent to a big works, five minutes before the works close, with the consequent loss of potential traffic.

In Argentina, on a line where there was one slow train a day with different schedules for different days of the week, a new service of railcars running to a considerably accelerated schedule at the same time each day of the week very quickly created a considerable traffic, and I am sure that a closer attention to the improvement of the average speed and regularity, and secondly, to the attractiveness and comfort of local and branch trains, would help enormously to regain traffic to the railway, even if it did mean taking that traffic from the half-railway-owned bus companies.

One other example: Many workers living in towns have a real opportunity of getting into the country only on Sundays, and yet in far too many cases, while the bus companies run half hourly or hourly services, the railway is content with a train morning, noon, and night, with the result that the would-be passenger, instead of the more comfortable train, is forced to use the bus not only for his Sunday outings but, by the power of suggestion, for his other journeys too.

The results of poor service, from the essence of human nature which is generally more ready to believe evil than good, is a far stronger anti-advertisement than the good advertisement provided by selected fliers, but it is very difficult to make people realise the intangible loss caused by dissatisfaction and grumbling where there is no question of actual hard cash involved.

Yours faithfully,

H. L. HAWKER

PUBLICATIONS RECEIVED

Klaar achter? (All right behind?). By J. B. Uges (Nono). Amsterdam: Andries Blitz. 8½ in. × 6 in. 259 pp. 100 photographic illustrations and numerous sketches by B. J. Kempers. Preface by the Management of the Netherlands Railways. Price f. 4·25.—While many railway books for the general public have been written in English, by writers such as Cecil J. Allen, and the late J. F. Gairns, in other countries this field of literature has been comparatively little explored. The present volume fills the gap for Dutch readers and contains a good account of railway working in the Netherlands, from the point of view of an enquiring member of the public, with as much explanation of railways in general as is essential to the theme.

The first railway in the country was opened between Amsterdam and Haarlem on September 20, 1839, and four days later the author's grandfather made the journey, of which an amusing account is given. The amount of detailed information is not quite as great as we could wish, the reader being assumed to be observant above the average, but, nevertheless, a very good understanding of the Dutch railway system is conveyed in the readable pages of Mr. Uges' book. The interest is sustained throughout, and much use is made of conversations between an enquirer and a railway official, which helps to make the reading attractive. Interesting chapters are those on railway technical and slang terms, the Utrecht Railway Museum, and the journey round the Netherlands by train. An appendix of dates of opening of all sections of the present Netherlands Railways is most useful for reference. There is nothing in the book, however, of any importance bearing on the light railways and steam trains of Holland, which is disappointing.

Anyone who reads German should be able to follow the text, with some help now and then from a dictionary. It is to be hoped that the book will achieve its purpose and induce a wider circle of the public to take an interest in the railways. It is well adapted to do so, but some parts could advantageously be expanded in a later edition.

The Law Relating to Smoke and Noxious Fumes. By the late Randolph A. Glen. Manchester, 2: The National Smoke Abatement Society, 36, King Street. 8½ in. by 5½ in. 24 pp. Price 1s. net.—In addition to a clear exposition of the law regarding the smoke nuisance, this book gives valuable examples of its operation. There is a section dealing with railways, wherein is quoted a passage of the Railway Clauses Consolidation Act of 1845 which lays down that every locomotive burning a fuel emitting smoke shall be constructed to consume this product, and that the use of an engine not conforming to this principle shall incur a penalty of £5 a day. By the Regulation of Railways Act of 1868, it was constituted an offence if a locomotive designed to consume its

own smoke was found to have failed to do so as far as was practicable on the occasion complained of. Cases are quoted to show that although a magistrate's conviction of a railway company under these enactments has been upheld on evidence that locomotives had emitted black smoke for three minutes when it was unnecessary to do so for more than one minute, and that a more smoky fuel than Welsh coal had been used, the Court did not assent to the contention that the mere fact of smoke issuing was sufficient in itself without evidence of default on the part of the company or its servants (*S.E.C.R.* v. *L.C.C.*, 1901). Where an engine designed to consume its own smoke had emitted it on two occasions, but through no default in the stoking or management, it was held that there had been no offence, although again the nuisance would have been less had Welsh coal been used (*L.C.C.* v. *G.E.R.*, 1906).

The Stock Exchange Official Year-Book, 1935. London : Thomas Skinner & Co., 330, Gresham House, Old Broad Street, E.C.2. 10¼ in. by 6¼ in. by 3½ in. Pp. i-cciv and i-3302. Price 60s. net.—This is the second issue of a work which last year for the first time amalgamated under its present title the particulars contained in the old *Stock Exchange Official Intelligence* and *Stock Exchange Year Book*. All the features which gave so much distinction and value to the former publications are retained at the same price as the old *Official Intelligence* and in a form which makes handling easier because of a more convenient shape and the thinner paper used. Considerable space is also saved by printing rearrangements in the different sections which are quite as easily readable as before, and in addition reference is appreciably facilitated by the tabs now inserted. This issue contains notices of 58 government and municipal loans and 272 companies which were not included in its predecessor, and one feature new to the book is a chronological table (at the end of the General Information) of debenture and other loans which cannot, normally, be redeemed *en bloc* before maturity.

In the early part of the volume special chapters deal with the finances of British municipalities and counties, India, the Dominions and Colonies (including results of State-owned Dominion and Colonial railways). Under the heading of British and Foreign Finance financial and statistical particulars are given of the Sovereign States of the world, and rates per £1 at which currency figures have been converted into sterling figures. In the chapter on Indian finance and under the heading Indian Railways particulars are supplied of the position of Indian railway contracts, dates of purchase, &c., and as to the annuities representing part of the purchase price for which several systems have already been acquired by the State. Full particulars of the London Passenger Transport Board appear under the heading "Public Boards." Statements showing the working results from 1925 onwards of the four principal British railway companies and their investments in transport undertakings are given. In the Dominion and Colonial Railways Section will be found useful information as to the reduction of the capital of the Great Southern Railways (Ireland) under the (Free State) Railways Act of 1933.

The Foreign Railways Section is particularly full and good. Immediately following the Water Works section is the Supplement, containing information received too late for classification. In this supplement we notice under the heading "London Passenger Transport Board," the award in the Tilling arbitration case and the interim payment on C Transport Stock. Mention is also made of the coming redemption of the 6 per cent. sterling bonds of the Midi and Orleans Railway Companies and the replacement of those bonds by a new 4 per cent. issue. After the supplement will be found the usual particulars, duly revised and brought up to date, relating to stamp duties, trustee investments, the public trustee, income tax, estate duty, &c.

Distant Indication and Control for Water Undertakings.—A useful illustrated handbook of information on distant indication and control for water undertakings has been published by Evershed & Vignoles Limited, Acton Lane Works, Chiswick, W.4. The apparatus described is designed to provide the engineer with a centralised means of observing conditions in the works under his charge and of operating the apparatus connected therewith. The booklet explains the application of electricity to these purposes, and a noteworthy merit of such systems is the ease with which automatic alarms can be introduced into the circuits of the recording devices. Distant control of pumping stations is also facilitated by electricity. A chapter on this subject illustrates remote control panels and illuminated diagrams in use by the L.M.S.R. and at Southampton Docks.

Nife Batteries.—The full benefits and economy of storage battery traction are experienced only if the cells used possess the qualities of long life and sustained output. The merits of the nickel-iron accumulator in this connection are well established, but additional and concrete evidence of its capacity is furnished in an illustrated booklet, published by Batteries Limited, of Hunt End Works, Redditch. A sectional diagram, forming the frontispiece, shows the all-steel construction of the Nife nickel cadmium alkaline cell, which makes mechanical breakages unknown. Other advantages are that the active materials are totally enclosed, and that the electrolyte is non-corrosive towards the plates and terminals. Among the experiences of users of these cells is quoted that of an English railway which equipped a fleet of 32 trucks, operating under severe conditions, with Nife batteries, and secured a minimum life of eight years. Several of them are twelve years old and still giving satisfactory service. Various industrial concerns have applied these batteries to standard-gauge electric locomotives for hauling railway wagons and to small mobile cranes.

Telegraph and Telephone Line Wire.—A folder received from British Insulated Cables Limited, Prescot, Lancs, gives particulars of hard drawn copper, bronze and cadmium copper wires for telephone and telegraph circuits. The hard drawn copper range varies in weight from 800 lb. to 70 lb. a mile and combines a higher electrical conductivity than obtains in any other commercial metal with good mechanical properties. Lower conductivity but greater tensile strength characterise the bronze wires, weighing from 300 lb. to 40 lb. a mile, while the cadmium copper series is equally strong for less weight and has a conductivity of over 85 per cent. of that of the hard-drawn copper. It also offers a high resistance to atmospheric corrosion.

Industrial Lighting.—We have received from the General Electric Co. Ltd., Kingsway, London, a most attractive brochure illustrating the uses of Osira lamps for industrial lighting. Developed over a period of years the Osira electric discharge lamp was first put on the market in 1932. First used for street lighting purposes, the lamp is now also recommended for a wide variety of industrial installations. Not only can full advantage be taken of the increased light output for the current consumed, but the colour and quality of the light, as compared with that of the ordinary incandescent lamp, have proved a definite advantage in giving greater sharpness of vision, particularly in the many industries where the working, handling, inspection and assembly of such materials as minerals and metals are involved. A price catalogue is appended.

The New Morris Electric Crane.—A new overhead electric crane incorporating modern improvements which entitle it to rank as a real advance in this type of machinery is described in an illustrated booklet published by Herbert Morris Limited, Loughborough. A carefully studied design has resulted in the combination of compactness and accessibility in the working parts. Alloy steel gears rotating in a totally enclosed oil bath are notable contributions to smoothness and silence of operation. Ball-bearings are fitted throughout in the main travel, cross travel and hoisting motion gearboxes. Also incorporated in the hoist mechanism are a quick-acting knock-off gear to prevent overhoisting and a neat design of brake with the electrical portion enclosed. A special dead slow drive can be fitted for foundry and similar work. The well-balanced design of the machine is reflected in the crane bridge and cage. Roller-bearings are fitted to the tram-wheels and the controls are disposed to all the swiftest and most accurate load handling combined with safety, economy and durability.

THE SCRAP HEAP

Science is resourceful. It couldn't pry open the Pullman windows, so it air conditioned the train.—*From the "Star" of Montreal.*

* * *

THE "LAND OF EVANGELINE ROUTE"

The Dominion Atlantic Railway, a subsidiary of the Canadian Pacific Railway, serves the north-west coast of Nova Scotia, the line running from Yarmouth, at the extreme south-west point of Nova Scotia, to Windsor Junction, 202 miles distant, on the

Photo] [R. F. Legget

Crest carried on the tenders of locomotives of the Dominion Atlantic Railways

Canadian National Railways main line. Somewhat unusually for North America, the locomotives of the Dominion Atlantic Railway are painted in a smart livery of crimson lake, and the metal-work of the engines is kept in a very spick-and-span condition. A crest is carried on the tenders, bearing the words "Land of Evangeline Route," and a representation of the lady concerned. The reference is, of course, to Longfellow's poem immortalising the name "Evangeline," which is now for ever linked up with this district.

* * *

Foreigner (at London terminal booking office): Ven I haf taken two teekets to Svancee, and, afterworts, I do not vant dem, can I haf de monnie back?

Booking clerk: Yes, if you bring them back, unused, the same day.

Foreigner: De same day? Perhaps I do not know for a veek.

Booking clerk: Then why not wait till you *do* know.

Foreigner: My wife, she is so uncertain. At 10 o'clock ve vill go, but at 11 o'clock ve vill *not*. At mid-day I must orter de taxi, and a leetle later I must disorder him. Den, perhaps tree days later ve will go in de eeffening, or ve may not go at all. Perhaps I had better vait.

* * *

WHO IS THE ENGINEER?

The following is a question put by the Bethlehem Steel Corporation to applicants for jobs. They are allowed 2½ hours to solve it:—

A train is operated by three men, Smith, Robinson, and Jones who are fireman, engineer, and brakeman, but not respectively. On the same train are three business men of the same name, namely Mr. Jones, Mr. Robinson, and Mr. Smith. Mr. Robinson lives in Detroit. The brakeman lives halfway between Chicago and Detroit. Mr. Jones earns exactly $2,000 per annum. Smith beat the fireman at billiards. The brakeman's nearest neighbour, who is one of the business men, earns exactly three times as much as the brakeman, who earns $1,000 per annum. The passenger who is named the same as the brakeman lives in Chicago. Who is the engineer?

* * *

A recent competition in *Time and Tide* produced the following suggestions for the telegraphic address of the London Passenger Transport Board:—

Uncomfortable, Joggy.
Fullup, Hoppit.
Blunderbusses, London.
Omnihop, Rushan bustle.
Fezpleese, Squeezem, London.

Although these suggestions can hardly be termed complimentary we think the board may be congratulated upon receiving such comparatively mild criticism from the readers of our controversial contemporary. Consternation might of course have arisen at 55, Broadway, had the reader who suggested "Fleas Regent" placed that address opposite the L.P.T.B. instead of Jubilee the Baby Chimp.

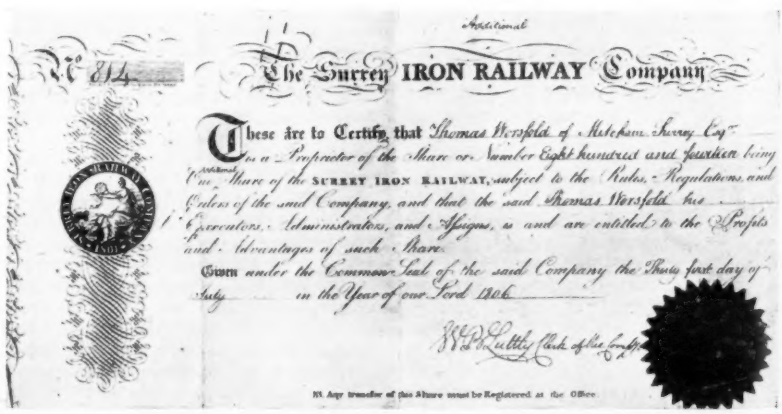
Much of the railway poetry quoted on this page in our issue of April 5 was by obscure or anonymous authors, but a certain number of more celebrated poets have tackled the same theme. Turning to names familiar in the anthologies, the volume of such verse seems at first to be limited. Momentary hope may be gleaned from the title of Wordsworth's poem "The Excursion," but the briefest study will show that it had nothing to do with cheap travel. It appeared, moreover, 26 years before the first venture of this kind by the Midland Counties Railway from Nottingham to Leicester in 1840. But if the trains were missing the prospective *clientèle* was there, as is apparent from the opening lines of "The Brothers" (first published in 1800):—

These Tourists, Heaven preserve us! needs must live
A profitable life: some glance along,
Rapid and gay, as if the earth were air,
And they were butterflies to wheel about long as the summer lasted.

The modern tourist rarely invites comparison with the butterfly, and Wordsworth may have been describing those of his day with good will rather than accuracy, but the lines are an interesting reminder of the fact that the railway merely facilitated and did not inaugurate the practice of travel for pleasure.

The poet lived to see the railway invade the Lake District he had so often celebrated in his verse and to write a pamphlet and two sonnets against the projected line from Kendal to Windermere. These were published in 1844, marking a noteworthy change of mind from that which had inspired his "Steamboats, Viaducts and Railways" eleven years earlier. Here his mood was one of tolerance:—

In spite of all that beauty may disown
In your harsh features, Nature doth embrace
Her lawful offspring in man's art; and Time,
Pleased with your triumphs o'er his brother Space,
Accepts from your bold hand the proffered crown
Of hope, and smiles on you with cheer sublime.



An interesting relic of the world's first public railway—a horse line authorised in 1801—is the share certificate (reproduced above) now in the collection of Mr. John Phillimore

OVERSEAS RAILWAY AFFAIRS

From our correspondents

SOUTH AFRICA

Natal Main Line Doubling

Many heavy and interesting works have been involved in the doubling of the Natal main line of the South African Railways, which is now nearing completion. No fewer than ten tunnels have had to be duplicated; their aggregate length exceeds two miles, and two of them are each over 1,000 yd. long. Entirely new tunnels have been driven parallel to and with a 12-ft. rock space between them and the old tunnels. Great care was taken not to damage the old tunnels or interfere with traffic, and only small charges were used for blasting. Two tunnels only now remain to be completed. The doubling has been brought into use in sections as finished, and two sections, one of them including the unfinished tunnels, are still in hand. Cuttings run up to 100 ft. in depth, and over 1,000,000 tons of stone have been excavated in aggregate throughout the doubling as a whole. The work was started about 3½ years ago, and should be finished within two or three months.

FRANCE

Extensive Programme of New Automatic Signalling Installations

The French railways have obtained a grant, under the new works scheme authorised by the State, of a sum of fr. 633 million (about £8,554,000 at the present rate of exchange) for the installation of automatic block signalling on considerable stretches of main line, as shown on the accompanying map, the longest being the P.L.M. line from Paris to Marseilles. This ambitious scheme is being undertaken as part of the general reform of the French signalling code already sanctioned by the Minister of Public Works. The new signalling is expected to be almost entirely of the colour light type, first used in France on the State Railways' suburban lines in 1924. Hitherto the employment of these signals has been made a little awkward on account of two lights being required for most of the regular signal indications. In the new "*Code des Signaux*," automatic block signals show only one light for each indication, red, yellow or green, and this results in a considerable saving in cost compared with the older practice. Double lights will only be seen in controlled signals. The adoption of automatic signals will enable a large number of intermediate block posts to be abolished with consequent saving, which, with the increased degree of safety obtained from continuous track circuiting, is considered to warrant the change. The existing automatic semaphore and "banjo" (P.D.) type signals—the latter extensively used on the Midi system—will no doubt remain until renewal is due, when the light type will replace them.

INDIA

Important Railway Works in 1933-34

The serious erosion of the river bank in the vicinity of the bridge over the River Sutlej at Gidarpindi (N.W.R.) also threatened the approach banks, seriously endangering the entire bridge structure and its approaches. It was therefore necessary to extend the upstream guide banks by 1,350 ft. at an estimated cost of Rs. 5·29 lakhs.

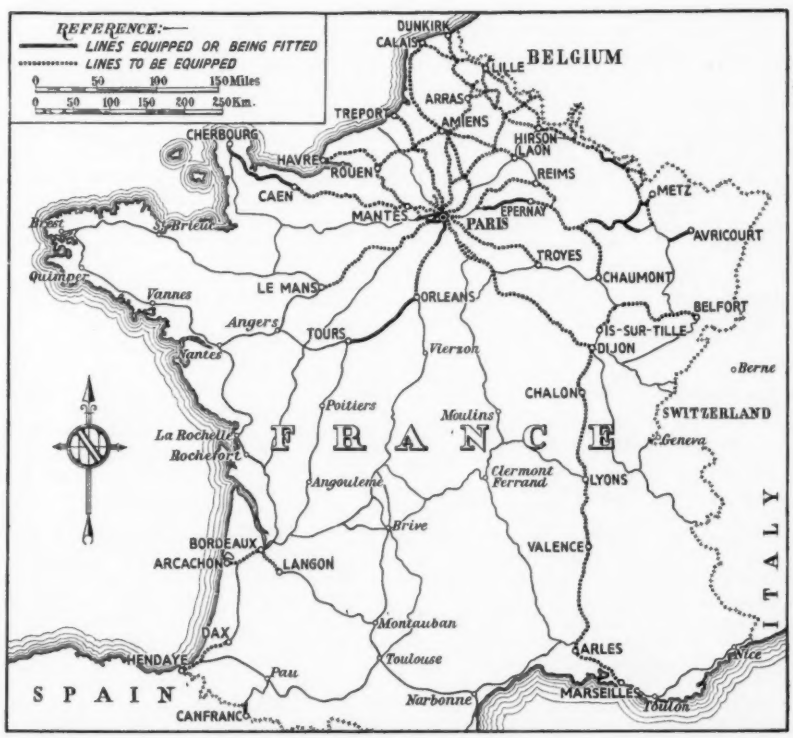
The main line of the North Western Railway between Lahore and Karachi follows the course of the Sutlej for a distance of six miles between Bahawalpur and Samasatta stations. As the distance between the river and the railway is not very great on this length, the railway is continually threatened by floods, and the safety of the railway has been a source of anxiety to the authorities for nearly 20 years. Efforts to train the river effectively having proved unsuccessful, it was decided to abandon the present alignment and divert it well out of the reach of the river. The cost of realignment was estimated at Rs. 3·56 lakhs.

Indigenous Timbers in Carriage Building

Although Burma teak is admittedly the most suitable timber for use in the building of railway carriages, the carriage and wagon shops of the Indian railways have long been experimenting with various other kinds of indigenous timbers in order to test their suitability for this purpose. On the East Indian Railway 23 bogie vehicles were constructed with kiln-seasoned timber and sent into traffic, and 46 vehicles, partly constructed of indigenous timber, passed through the shops for overhaul during the year 1933-34. The timber was found to be still serviceable, though in some cases shrinkage and warpage had taken place. Out of 21,231 tons of timber consumed in the carriage and wagon shops in the year 1933-34, some 67 per cent. consisted of teak and other Indian miscellaneous timbers. On account of the reduced programme for new carriages, the proportion of Burma teak fell to 33 per cent.

Wooden Sleepers

Despite the increasing use of steel and cast iron sleepers on Indian railways, the track mileage of all gauges on Class I railways equipped with wooden sleepers stood at 28,870 miles on March 31, 1934, representing 54 per cent. of the total track mileage. The



Sketch map showing the French lines to be equipped with automatic block signalling under the new works scheme

sleeper treating plants at Dhilwan (North Western Railway) and Naharkatiya (Assam-Bengal Railway) for the impregnation of soft wood sleepers with a mixture of 40 per cent. creosote and 60 per cent. liquid fuel, continued to operate satisfactorily during the year 1933-34. The cost of treatment at Dhilwan was a little higher than in the previous year on account of the greatly reduced number of sleepers treated.

New Railway Hospital

A new Eastern Bengal Railway hospital, to be known as the B. R. Singh Hospital after the Agent, was opened in Calcutta recently by Sir Guthrie Russell, Chief Commissioner for Railways. The new building is replete with modern equipment of all kinds, and will cater for the needs of a railway which serves a notoriously unhealthy area, where skilled medical and surgical aid is not easily available.

Value of Railway Materials Purchased

During the year 1933-34, the value of stores purchased by the State-owned railways of Class I amounted to over Rs. 11 crores, and there was an increase of Rs. 93 lakhs over the figures for 1932-33. The value of imported stores increased by Rs. 16 lakhs, and that of indigenous materials rose by Rs. 77 lakhs, rolling stock alone accounting for Rs. 66 lakhs. The values of the principal items of purchase are given in the following table:—

Items	Total Value of purchases	Value of imported materials	Value of indigenous materials
	In lakhs of rupees		
Rolling stock ...	220	125	95
Tools and stores	347	187	160
Permanent way ...	201	9	192
Electric plant ...	53	50	3
Building and station materials and fencing ...	20	11	9
Bridge work ...	21	13	8
Workshop machinery ...	16	16	—
Engineers' plant	9	8	1
Other materials (coal, coke, stone bricks, lime, etc.) ...	310	18	292
Total Rs. crores	11·97	4·37	7·60

Special Pilgrim Traffic

Although pilgrim traffic to the numerous places of religious interest continues throughout the year, there are occasions when special arrangements have to be made by the railway authorities to meet the inordinate rush of pilgrims to a particular place. *Melas*, or religious fairs, are usually occasions when extra trains have to be run or additional coaches added to the regular train services. Intensive propaganda by the publicity sections of the railway administrations have greatly stimulated pilgrim traffic of recent years, and during the year 1933-34 *mela* traffic was very satisfactory. The *Sinhast* fair at Ujjain was held after twelve years in April, 1933, and during the full month of the *mela* 115,000 passengers travelled to Ujjain and 130,000 from Ujjain. The entire medical and sanitary arrangements at the station were controlled by the Medical Department of the B.B. & C.I. Railway.

The Kurukshetra *mela* of 1933 was specially advertised, and in consequence drew a phenomenal gathering. The following figures of inward and outward passengers at Kurukshetra for the period of the *mela* from August 10 to 25 are illuminating:—

	1933	1932
Inward	154,941	3,244
Outward	108,579	5,534

The Adh Kumbh *mela* at Hardwar was held from March 20, 1933, and continued during April. Rumours of the outbreak of plague at Hardwar adversely affected the traffic, but, nevertheless, the number of passengers booked to Hardwar, Jawalapur and Rikhikesh during March and April, 1933, went up to 220,897, and the earnings of the inward traffic alone over the East Indian Railway amounted to approximately Rs. 2,81,250. Keen road motor competition between Saharanpur and Hardwar was met to some extent by arranging to run all special trains from the North Western Railway through to Khanalampura West, where there were no facilities for motor buses to park. The imposition by the local authorities of a pilgrim tax on road traffic as well as rail traffic, also tended to equalise the competitive position.

RHODESIA

Imperial Press Conference

The two special trains provided by the South African Railways for the Imperial Press Conference tour of the Union and of Southern Rhodesia each covered nearly 2,500 miles over Rhodesia Railways metals, between February 13 and 21. [The itinerary of the tour and composition of the trains were described in our Overseas columns on March 8.—Ed., *R.G.*] Perfect weather prevailed, and after the recent heavy rains the country looked its best. At the last function before leaving Rhodesia, the delegates expressed their grateful thanks for their great welcome in Rhodesia, and paid particular tribute to the railway officials who had done so much to make their tour comfortable.

Pay Cuts Withdrawn

The Rhodesia Railways administration has restored the remaining portion of the temporary pay reductions and discontinued the short-time working from March 1. The reduced rates of pay were brought into operation owing to the decline in traffic during 1931, but with the recovery in trade part of the cuts were discontinued in November, 1933. The net operating revenue for the first two months of the current financial year shows an increase of £99,458 over the previous year and, in announcing the restored pay conditions, the General Manager stated that they were made in the hope that the revival of trade would be maintained and that railway traffics would continue to improve.

Accelerated Train Services

Considerable improvements in Rhodesian train services are to be introduced in the new winter timetables, which will give faster and more convenient travelling, particularly to and from towns in the Union. The Rhodesia Express, conveying the overseas mail from Capetown, will reach Bulawayo an hour earlier than at present, which reduces the 1,360-mile journey to 45 hr. 22 min., while the Rhodesia Limited, with the outward mail, will be cut by 30 min. The retiming of the south mail from Bulawayo on Mondays will give a much accelerated service, saving 5¼ hr. to Johannesburg and 8½ hr. to Capetown, while to Durban, by connecting with the Rand-Natal Express, the journey time will be reduced from 62¾ hr. to 47½ hr. A saving of 4¼ hr. will also be made once weekly on the Bulawayo-Salisbury journey.

NEW SOUTH WALES

Results for the Last Quarter of 1934

Compared with the corresponding (last) quarter of 1933, earnings increased by £336,492 and expenditure by £26,395. Over 5½ million more passengers were carried and over 200,000 additional train miles were run. Unlike those on the majority of railways in other parts of the world at the present time, New South Wales coaching earnings improved by nearly £158,000. Meanwhile goods earnings were up by £166,500. Earnings per train-mile improved by 7½d., from 12s. 1d. to 12s. 8½d., but expenditure fell by 2¼d. per train mile, from 8s. 2d. to 7s. 11¾d. The operating ratio improved from 67·55 to 62·82 per cent. The position therefore appears to be very satisfactory.

CANADA

Hudson Bay Route

In the Canadian House of Commons on April 8, Mr. R. J. Manion, Minister for Railways, expressed the belief that when Western Canada returned to normal conditions, the Hudson Bay route would pay its way. Last year 4,000,000 bushels of wheat, as well as some cattle, flour and timber, were shipped at Churchill, but there was a net operating deficit on the Hudson Bay railway of $137,000, and at the port one of $87,000. The elevator at Churchill however, showed a profit of $17,000. Discussion in the House strengthened the belief that considerably more traffic would use this route in the coming season. The recent reduction in hull insurance is favourably affecting these prospects, and in addition, the Saskatchewan wheat pool intends materially to increase its exports via Churchill this year.

IMPRESSIONS OF OVERSEAS TRANSPORT

XVII—A survey of the methods by which the Queensland Government Railways have promoted the economic and social development of the State

By A. W. ARTHURTON, formerly Secretary, British Railways Press Bureau

IN few countries has the railway done more to further economic progress than in Queensland, where vast expanses of fertile soil have been developed to a surprising degree. Mr. J. W. Davidson, the present Commissioner of Railways for the State, joined the railway service as a boy and worked his way up through the various grades to stationmaster, Traffic Superintendent, General Manager, and finally to his present position. In earlier days the railways of Queensland had no through routes to north, south or west. Each section of line built was isolated from other sections, and Mr. Davidson recalled to me, with justifiable pride, his early days as stationmaster at Bowen, when he controlled the staff, working, and maintenance of the line over a stretch of 70 miles, and was, as he said, a sort of railway "Pooh-Bah."

At the present time he is a benevolent autocrat of over 6,000 miles of railway, with practically unlimited powers, subject only to the approval of the Minister of Transport and Parliament. He is also Chairman of the Road Board, which exercises complete control of road transport and, while conserving the interests and revenues of the railways as a State-owned concern, he is mindful of the broad interests of the public and believes that railway and road transport services can be so co-ordinated as to give the best possible service to the community.

The Commissioner of the Queensland Railways is subject to no control by a rates tribunal in the matter of railway charges, but can apparently authorise any rate to secure or retain traffic, such rates having to be reported to the Minister and Parliament annually. At the same time, his relations with road carriers are amicable, and he recognises that road transport has a definite place in the transport economy of the State. His relations with Labour are also very friendly. He was appointed Commissioner by a Labour Government, confirmed in his appointment by a Conservative administration and re-appointed by the present Labour Government. He has therefore the confidence of Parliament and has also earned the respect of the railway staff, who admire him for his knowledge and ability as well as for his good humour and justice.

The Divisional System

The railways of Queensland have been reorganised by Mr. Davidson on the divisional system. There are three general managers of respectively the Southern, Central and Northern areas, each of whom has under him a Locomotive Engineer, Civil Engineer, and Traffic Superintendent, with their assistants. The former Chief Locomotive Superintendent and Chief Engineer, however, now act independently for the Commissioner over the whole of the system, and report directly to him on all matters within their particular provinces.

Queensland Railways claim to be pioneers in many phases of railway practice. They were the first in Australia to introduce automatic signalling and a C.O.D. parcels system; the first to experiment with the diesel engine, and they have the largest number of railcars in the Commonwealth. The railways were built for the development of the country, and even the large areas of tropical North Queensland are occupied with extensive sugar plantations, which provide heavy traffic for the railways and are a big asset to the State. Queensland is rapidly recovering from the depression, as may be gathered from the healthy condition of railway revenues, which in the six months ended December 31 last, exceeded the estimated total for the whole year by £300,000.

Rail Motor Progress

The growth of rail motor services on the branch lines of the Queensland Railways* is indicated by the great increase in railcar mileage. In the year 1926-27, when the type of car now in use was first introduced, the mileage was 39,885 while in 1933-34 it had risen to 1,564,842. There are 60 cars now running, with 105 trailers. The development of the diesel engine abroad has been closely watched in Queensland, and a diesel engine of 130 h.p. has recently been purchased to test the suitability of this type of power unit for the conditions under which railcars are required to operate in Queensland, and is now in service.

Mention has been made of the developmental function of railways. In Queensland this has been carried a stage further in recent years, when long periods of drought dry up the grass and cattle and sheep are in danger of dying from want of fodder. In such cases the railways come to the aid of the farmer by carrying fodder at very low rates or transporting the animals to districts where food is more plentiful.

Queensland takes a deep interest in education, but the inhabitants of many districts hundreds of miles inland have no opportunity of sending their children to secondary schools. Here the railways step in and in conjunction with the educational authorities provide instructional cars which are stationed at various points on the line from time to time so that children, as well as adults, may take a fortnight's course in carpentry and other crafts, domestic science, dental clinics, and so on.

The train control system on the Queensland Railways has been considerably extended during the past year and is now in operation in various areas centring around Brisbane, where the train despatcher's office is located. The advantage of this on long sections of single line is obvious.

The prospects of the railways of Queensland are fairly bright. The tide of depression, as far as Queensland is concerned, is most definitely on the ebb. The tonnage of sugar cane and raw sugar is increasing, general merchandise traffic is improving, and brighter conditions in the building trade are being reflected in the earnings from log and sawn timber traffic. Maize and cotton traffic is heavier and the export of fruit to the Southern States is increasing, although still below normal. Queensland, with its sub-tropical climate and fertile soil, particularly along the coastal areas, is a wonderful country for growing the citrus and other fruits for which it has become famous, while the unsurpassed wealth of grasses in those areas is most suited for dairy farming and the rearing of sheep and cattle. Queensland already shows greater progress in recovery than any of the other States, and the future is bright with hope and achievement.

* See the *Overseas Railway Number* of THE RAILWAY GAZETTE, November 28, 1934.

SUPERHEATING ON LOCOMOTIVES

By PROFESSOR G. V. LOMONOSSOFF, Dr.-Ing., and C. A. J. ELPHINSTON, B.A.

SUPERHEATING is now universally applied to locomotives for main line service. Nevertheless its influence on the various processes of steam production and utilisation is not altogether understood.

In accordance with Rankine's theory, which ignores the losses due to wire drawing and the missing quantity, superheating can increase the thermal efficiency of the engine to only a slight extent.* Usually its favourable effect is explained by its influence on the missing quantity. From this point of view, however, we are led to postulate a maximum temperature or degree of superheating which it is unprofitable to surpass.

As is well known the missing quantity consists of two parts, losses of heat to the cylinder walls and ports, and actual leakages of steam and, consequently, heat. In accordance with Doerfel's experiments the former loss reaches a minimum when the difference Δ between the superheated and saturated steam temperature is about 125° C. In Fig. 1, κ the ratio between the heat absorbed by the walls and the total heat brought into the cylinder, is shown against Δ, the degree of superheat. It is also

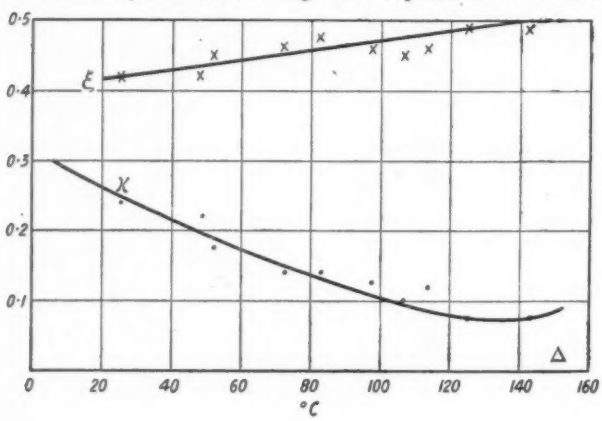


Fig. 1

established that superheating increases the fluidity of steam and thus the leakage increases with the degree of superheat.

On the other hand, the phenomenon of wire-drawing is decreased by the increased fluidity of the steam, and for locomotive service, this is of no less importance than the decrease of the missing quantity. Strahl was the first to point this out.† The same results were obtained during 1912 and 1913 by the first writer on Russian locomotives ‡ and later tests gave confirmation of this fact. In Fig. 2 the ratio ξ of mean indicated to boiler pressure is plotted against different steam temperatures for various cutoffs ε, and speeds Υ m.p.h. for an 0-10-0 locomotive. Very similar results had been obtained by Doerfel much earlier on an experimental engine, and Fig. 1 also shows his curve of ξ against Δ.

However, the results obtained by the first writer on an 0-8-0 compound locomotive were still more illustrative. On this locomotive the steam temperature reached 400° C., and under this condition the thermal efficiency of the engine only, η_m, reached 12 per cent. Attempts were made to

* Sir A. Ewing, "The Steam Engine," 1926, p. 145.
† *Organ*, 1908, p. 375.
‡ *Glavneishie Rezultaty*, 1913, p. 60; Lokomotivversuche in Russland, 1926, pp. 194–199.

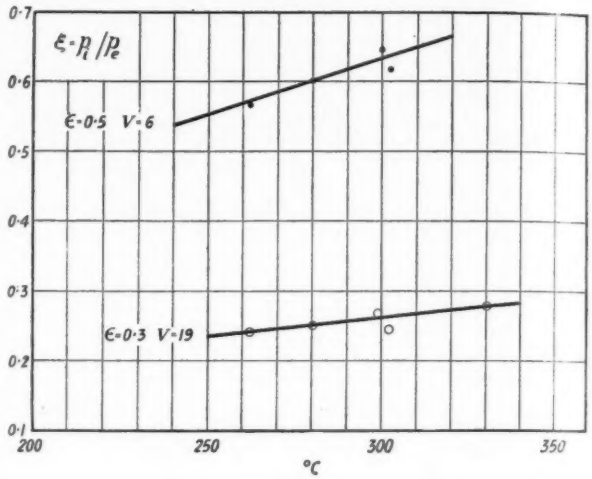


Fig. 2

reach higher temperatures, but some difficulties with lubrication occurred. But from the thermal point of view, it was quite clear that the most favourable temperature lay over 400° C. (750° F.).

This question of the most favourable superheated steam temperature has also been very carefully investigated on the German State Railway. In accordance with these tests, Strahl suggested that every 5° C. increase of temperature gives about 1 per cent. economy. Professor Nordmann, however, did not reach such definite conclusions after the recent and more exact experiments,* but

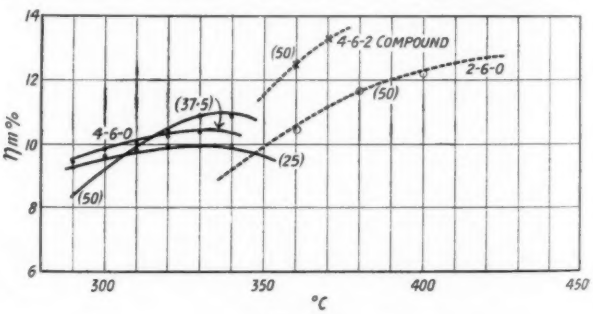


Fig. 3

stated that there appeared to be a certain most favourable steam temperature for every type of locomotive.

Fig. 3 gives some curves obtained from Professor Nordmann's data, which show the thermal efficiency of the engine only, η_m, as a function of the steam temperature. The figures in brackets refer to speed in m.p.h. The solid lines relate to the old Prussian (4-6-0) type P.8, and the dotted lines to modern types of the German State Railway. The former show a maximum near 350° C. For some old Russian locomotives this maximum occurs at still lower temperatures.

In the writers' opinion, this depends entirely on leakage. Piston valves as first generally fitted to locomotives with superheaters were of the type shown by Fig. 4, and with this construction a certain amount of leakage cannot be

* *Organ*, 1931, pp. 241–243.

avoided. Later, however, the single wide ring has been replaced by a number of narrower rings as shown in Fig. 5, and with this type the leakage should not exceed 3 per cent. of the total steam production if the valves are properly maintained. With broad ring valves in fair condition the leakage will be about thrice as much.

It is also well known that the steam temperature does

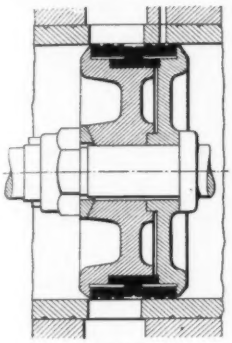


Fig. 4

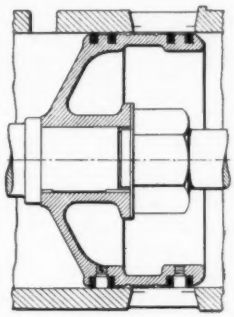


Fig. 5

not remain constant, but depends on the rate of liberation of heat in the firebox, and on the humidity of the steam evaporated. Fig. 6 gives the relation between steam temperature and the rate of evaporation z in lb. per sq. ft. per hour for the Prussian type P.8. The curves obtained on the track and in the laboratory are distinguished by the letters " T " and " L."

The first writer obtained similar curves for Russian locomotives. In all cases steam evaporated when the locomotive is moving is wetter than when it is working on a test plant.

On the other hand, the dryness of the steam depends on the quality of the water used, and usually diminishes if the water contains acids. The worst effect takes place when alkaline water is added to a boiler full of acid water or *vice versa*; the reaction causes excessive foaming. This had to be done at Kara Chokat on the Tashkent Railway, and the superheat usually diminished by 50°-60° C., while it even disappeared entirely on occasions.

(*See editorial note on page* 719)

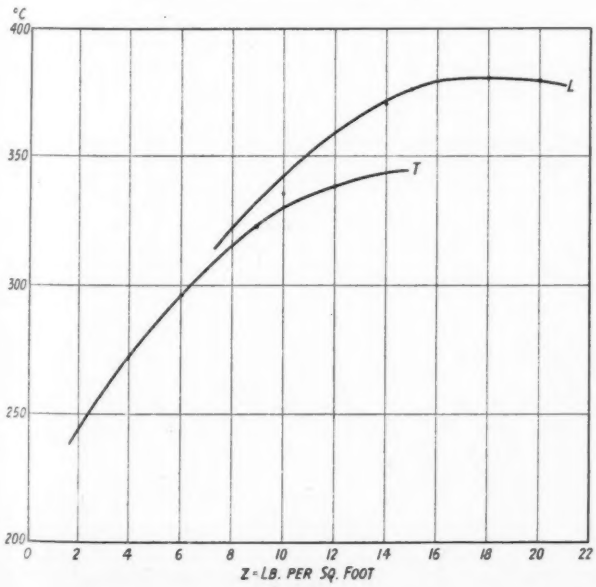


Fig. 6

REVISED B.E.S.A. RAIL

AN important revision, dated March, 1935, of the British Standard Specification and Sections for Bull-head Railway Rails has just been published. Originally drawn up in 1909, this specification has been previously revised in 1922 and 1928, so that this is the third revision. The most important development is the inclusion, for the first time, of alternative analyses, termed " medium manganese " analyses, designed to cover the manganese content for rail steel which is now becoming so popular. At the same time, the " lower carbon " analyses of the previous specification are omitted, leaving only " higher carbon " and " medium manganese." In general, the medium manganese analyses specify from 0·90 to 1·20 per cent. manganese, and a reduction of 0·05 per cent. in the carbon content of the higher carbon analyses, the percentages of other elements remaining unchanged. The new medium manganese analyses are therefore as follow:—

Process	Basic Open-hearth per cent.	Acid Open-hearth per cent.	Acid Bessemer per cent.
Carbon	0·50—0·60	0·45—0·55	0·40—0·50
Manganese ..	0·90—1·20	0·90—1·20	0·90—1·20
Silicon	0·10—0·30	0·10—0·30	0·10—0.30
Phosphorus ..	Max. 0·05	Max. 0·06	Max. 0·06
Sulphur	Max. 0·05	Max. 0·06	Max. 0·06

The only other difference from the previous higher carbon specification is that in the basic open-hearth process phosphorus is permitted up to 0·05 instead of only 0·04 per cent., which is reasonable in view of the lowering of the carbon percentage. The revised higher carbon analyses are:—

Process	Basic Open-hearth per cent.	Acid Open-hearth per cent.	Acid Bessemer per cent.
Carbon	0·55—0·65	0·50—0·60	0·45—0·55
Manganese ..	Max. 0·90	Max. 0·90	Max. 0·90
Silicon	0·10—0·30	0·10—0·30	0·10—0·30
Phosphorus ..	Max. 0·05	Max. 0·06	Max. 0·06
Sulphur	Max. 0·05	Max. 0·06	Max. 0·06

The alteration here is that the permissible maximum of manganese, with unchanged carbon limits, has been raised from 0·80 to 0·90 per cent., and in the basic open-hearth process the phosphorus limit has also been relaxed, as in the medium manganese analysis, from 0·04 to 0·05 per cent.

No change is made in the falling weight test provisions, but in the tensile test, in the case of rails made from the medium manganese analyses, no upper limit of tonnage is laid down. This is, of course, to the user's advantage, as he is always protected by the minimum percentage of extension specified, which is unchanged (12 per cent. with tonnages up to 50, and 10 per cent. with tonnages over that figure), and provided that the extension percentage is satisfactory, the higher the tonnage the better the wearing capacity of the rails without any fear of brittleness.

The only further alteration in the specification relates to short length rails. In the previous specification they could claim only that a minimum of 7½ per cent. of every rail order should be specified in shorter than the standard lengths, for switch and crossing or closure uses. This ensured that the contractor should not have left on his hands large tonnages of rails which had come slightly short of the full lengths in the mill, or had had to be rejected in consequence of defects at one end only. In the case of contracts for 60-ft. rails this percentage is now increased to 12½, or one-eighth of the tonnage. This is an all-round advantage, as present-day switch and crossing demands invariably find a use for the whole of this high percentage and, on the other hand, rail defects are so reduced with modern manufacturing methods, and higher manganese contents, that a large proportion of the short length orders have to be cut as multiples in the mill, and subsequently cold sawn to the correct lengths.

FRENCH LOCOMOTIVE TRIALS

Remarkable results have been obtained with one of the Paris-Orleans-Midi Railway 4-8-0 rebuilt express engines on the lines of the Nord

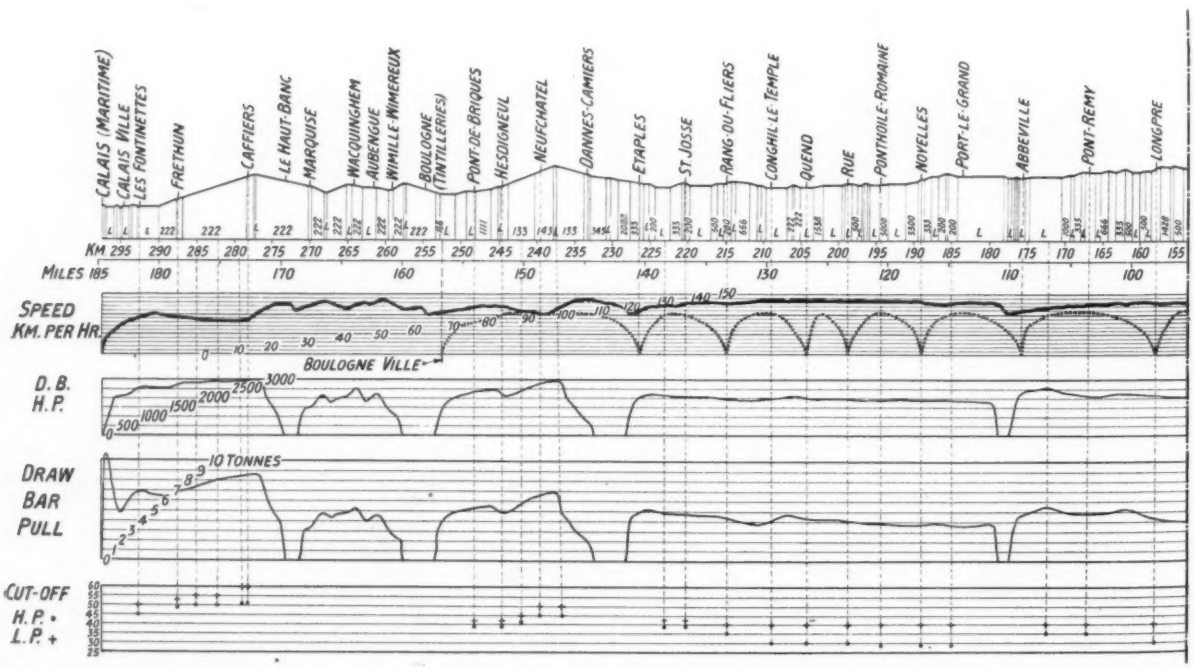
FREQUENT reference has been made in past issues of THE RAILWAY GAZETTE to the remarkable work done by the rebuilt Pacifics and 4-8-0 engines of the Paris-Orleans Railway on the Tours-Bordeaux and Vierzon-Toulouse lines. In the course of recent visits to France we travelled many hundreds of miles on the footplates of these two classes, including a journey on some trial runs on the Nord system, where the performance of one of the 4-8-0 locomotives on the Paris-Calais line probably excelled anything that has hitherto been done on that section.

Some time ago the 4-8-0 locomotive No. 4.707 was transferred from its home shed, Brive, to the Nord depot at La Chapelle in Paris, for testing on fast and heavy traffic between Paris and Boulogne, where fast trains with numerous stops over certain sections and long non-stop runs over others were getting beyond the limit of Pacific haulage, owing to the introduction, in increasing numbers, of all-steel carriages. It was also desired to test the capabilities of an eight-coupled engine on express work corresponding to the haulage of the heaviest boat trains. These trials were undertaken at the instance of M. Lancrenon, Ingénieur en Chef du Matériel et de la Traction, Chemin de fer du Nord, and were conducted by the Office Central d'Etudes des C. de fer français (O.C.E.M.) with the assistance of M. André Chapelon, Ingénieur du Matériel, C. de fer de Paris à Orléans-Midi, the designer of the locomotive. The dynamometer car of the O.C.E.M. was attached to the test train on all runs, and one of the Nord standard self-trimming tenders carrying 9 tonnes of coal and 37 cu. m. (8,150 gal.) of water was coupled up in place of the six-wheeled P.O. tender.

Fast Stopping Train Tests

On the first series of trials the load was made up of 16 all-steel vehicles and the dynamometer car, totalling 758 tonnes (745 tons). On the northbound runs the train started from Landy shed, and was scheduled to cover the 252·6 km. (157·3 miles) to Boulogne-Ville in 3 hr. 58 min. inclusive of 15 intermediate stops. On the return trip the overall time was the same, but the running time was ten minutes less owing to the duration of the stops being longer. The booked start-to-stop times were mostly improved upon, as may be seen by the dotted speed curve incorporated in the diagram reproduced at the foot of this page and the next.

Outputs of 2,500 to 2,650 d.b.h.p. were recorded when running up the 1 in 200 grades on the south side of the bank to Survilliers, the summit of which was topped at speeds varying from 100 to 105 km.p.h. (62-65 m.p.h.). On the run shown in the graph, the 14·4 km. (8·94 miles) up approximately 1 in 250 from Clermont to St. Just, on the south side of Gannes bank, were covered, start to stop, in 11 min. 26 sec., at an average of 73·7 km.p.h. (45·9 m.p.h.), with a top speed of 105 km.p.h. (65·2



Dynamometer car record of trial trip with Paris-Orleans Railway 4-8-0
The dotted speed curve shows the performance of the same

m.p.h.) and a peak d.b.h.p. of 2,600. From the re-start, Gannes 6·5 km. (4·04 miles) was passed in 6 min. 28 sec. at 93 km.p.h. (57·8 m.p.h.) with a d.b.h.p. of 2,450. Along the 43 miles of generally level line from Ailly-sur-Somme to Quend-Fort-Mahon, No. 4.707 achieved start to stop averages of 86·2 km.p.h. (53·7 m.p.h.) over the 17·5 km. (10·87 miles) from Longpré to Abbeville; 80 km.p.h. (49·7 m.p.h.) over the 14·4 km. (8·94 miles) from Abbeville to Noyelles; 72·7 km.p.h. (45·3 m.p.h.) over the 9·9 km. (6·15 miles) from Noyelles to Rue and 65·6 km.p.h. (34·7 m.p.h.) over the 5·2 km. (3·23 miles) from Rue to Quend. After each stop the train was accelerated to at least 100 km.p.h. (62 m.p.h.). A maximum of 3,000 d.b.h.p. was recorded after starting from Etaples, when a speed of 60 km.p.h. (37·3 m.p.h.) was attained in 1·5 km. (0·93 mile) up a grade of 1 in 500. Neufchatel summit was passed at 100 km.p.h. (62 m.p.h.) in 9 min. 03 sec. from Etaples, and Boulogne-Ville 26·1 km. (16·2 miles) reached in 20 min. 16 sec., a start to stop average of 76·6 km.p.h. (47·75 m.p.h.) The coal consumption was 112 lb. a mile over the whole distance from Paris to Boulogne and the firing rate 93 lb. per sq. ft. of grate per hour.

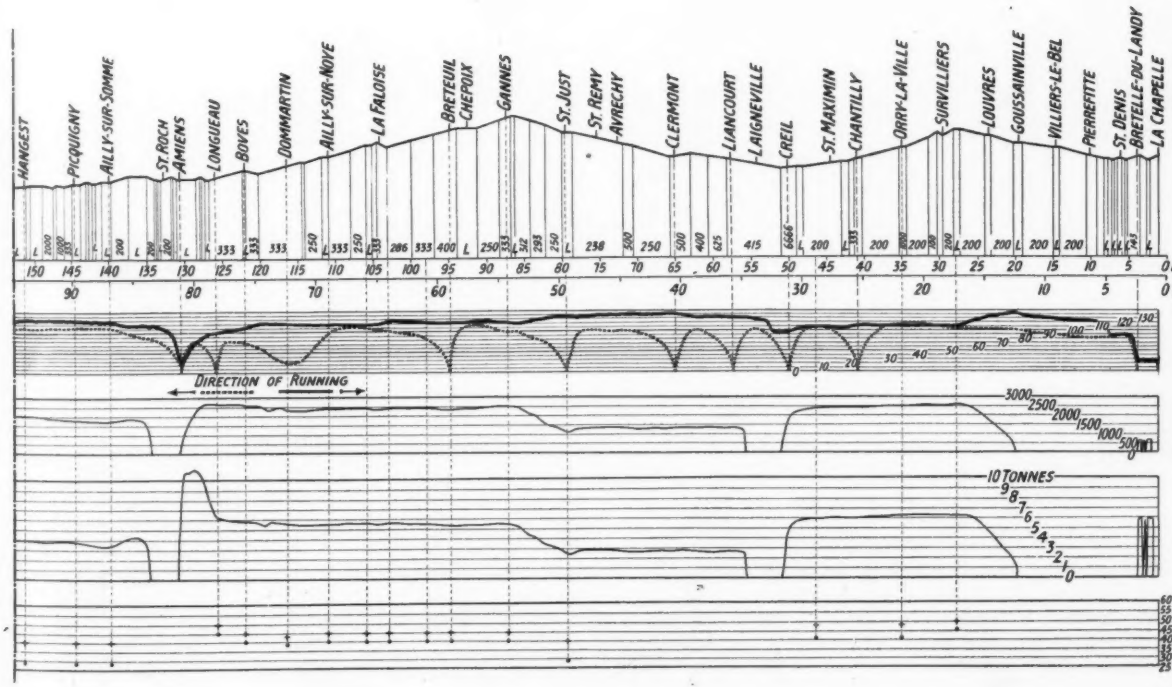
In the reverse direction there was a violent south-east wind blowing across the track as far as Amiens, and after this mist and heavy rain. Despite these adverse factors and a stop for 20 seconds before Creil, La Chapelle was reached in exactly four hours, or only 2 minutes above schedule, but some assistance was received by cutting the station stops. The speeds at the summits were 86 km.p.h. (53·5 m.p.h.) at Neufchatel, 103 km.p.h. (64·5 m.p.h.) at Gannes, and 99 km.p.h. (61·5 m.p.h.) at Survilliers, the last-named being a remarkable figure in view of the Chantilly stop. Orry-la-Ville, 5·6 km. (3·5 miles) from Chantilly, was passed at 84 km.p.h. (52·2 m.p.h.) in 6 min. 24 sec., and Survilliers station, 11 km. (6·83 miles) a 95 km.p.h. (59·0 m.p.h.) in 9 min. 57 sec. the d.b.h.p. on this section being 2,750 to 2,800 with cut-offs of 52 per cent. h.p. and 60 per cent. l.p.

High-Speed Runs

On all the above trials the French legal maximum speed of 120 km.p.h. (74·6 m.p.h.) was rigidly adhered to. In the high-speed tests between Paris and Calais this was waived, and although a nominal maximum of 140 km.p.h. (87 m.p.h.) was provisionally fixed the speed was allowed to exceed this limit. The trailing load was made up of all-steel stock to 646 tonnes, and the provisional booking for the 184 miles was 167 min. in each direction, including a seven-minute stop at Amiens.

In the up direction the train averaged 117·5 km.p.h. (72·9 m.p.h.) start to stop from Calais Maritime to Amiens, and 110 km.p.h. (68½ m.p.h.) from there on to La Chapelle, including a very slow pull in. From Amiens to St. Denis the average was 74½ m.p.h. A log of the run is given in the table below, but full particulars of the complete run may be obtained from the dynamometer car record which we publish herewith, by the courtesy of M. Lancrenon. The start out of Calais Maritime was in 55 per cent. h.p. and 60 per cent. l.p. cut-off and about ⅞ regulator opening, but the cut-off was brought back after half a minute to 45 per cent. h.p. and 50 per cent. l.p. Sand was applied for the first 20 sec. The fire was almost level with the bottom of the firehole at the back, and the glass was full at the start but had fallen to ¾ at Fréthun. The boiler pressure was maintained at 20 hpz. (290 lb. per sq. in.) throughout the run, but unfortunately we were unable to read the steam chest pressures as the gauge needle was broken. Normally there is a drop of barely half a hectopièze (7 lb.) between the boiler and the steam chest in these engines with the regulator wide open.

Passing Fréthun at 94 km.p.h. (58·4 m.p.h.), the 9 km.



locomotive hauling a 635-ton train between Calais and Paris on the Chemin de fer du Nord
locomotive on a 745-ton fast stopping train between Paris and Boulogne

(5·6 miles) of 1 in 125 up to Caffiers were surmounted at a minimum of 82 km.p.h. (51 m.p.h.), with an acceleration to 98 km.p.h. (60 m.p.h.) on the easier grade near the summit. With cut-offs of 50 per cent. h.p. and 55 per cent. l.p., the pressure was maintained at 20 hpz. (290 lb. per sq. in) and the intermediate receiver pressure at 5-5½ hpz. (72-80 lb. per sq. in.); the temperature of the superheated steam was 370° C. (to which it had risen at Fréthun) and the exhaust steam temperature was 160°-165° C. The smokebox vacuum which averaged 400 mm. (15·75 in.) of water from Calais to past Les Fontinettes, never dropped below 500 mm. (19·7 in.) all the way up to Caffiers, and rose as a maximum to about 530 mm. (20·8 in.); the water level fell merely from ¾ to a full ½ glass. A d.b.h.p. of 2,700-3,000 was sustained up the greater part of the grade. Neufchatel bank was rushed at a minimum of 103 km.p.h. (64 m.p.h.) and a rapid acceleration made down the other side before slacking to 105 km.p.h. (65·2 m.p.h.) at Etaples. Along the 44 miles of almost level from south of Rang-du-Fliers-Verton to Ailly-sur-Somme, speed ranged from 125 to 135 km.p.h. (77·7 to 84 m.p.h.), except for the slack to 104-105 km.p.h. (64·5-65·2 m.p.h.) at Abbeville, and the 75 km. (46·6 miles) from Rang to Ailly occupied only 35 min. 5 sec., an average of 128½ km.p.h. (79·7 m.p.h.). Over practically the whole of this distance the cut-offs were 30 per cent. h.p. and 40 per cent. l.p. with the regulator ¾ to ⅞ open. The boiler pressure was maintained at 20 hpz. (290 lb.), the intermediate receiver pressure at 4-4¼ hpz. (58-62 lb. per sq. in.), and the smokebox vacuum at 350 mm. (13·8 in.). The temperature of the superheated steam kept steadily to 375-380° C. and the exhaust steam temperature to 160° C.

From the Amiens start, Longueau, 4·6 km. (2·86 miles) was passed in 4 min. 32 sec. and the 80·3 km. (49·9 miles) to passing Creil (slack) at 95 km.p.h. (59 m.p.h.) occupied only 40 min. 53 sec., an average of 120 km.p.h. (73·3 m.p.h.) Up to Gannes speed did not fall below 118 km.p.h. (73·5 m.p.h.), and on the final 1 in 250 varied from 122 to 127 km.p.h. (76 to 79 m.p.h.), the output on this section being 2,350-2,500 d.b.h.p. with 40 per cent. cut-off h.p. and 45 per cent. l.p., and ⅞ regulator. Up to Survilliers the speeds on the 1 in 200 were 109-110 km.p.h. (67·9-68·3 m.p.h.) before Chantilly and 110-114 km.p.h. (68·3-71·0 m.p.h.) thence to the summit, which was passed at 112 km.p.h. (69·6 m.p.h.) with an output of 2,600 d.b.h.p.

No less noteworthy were the drawbar horsepowers when running downhill at higher speeds. On the 1 in 250 north of Clermont at a speed of 135 km.p.h. (83·9 m.p.h.), the dynamometer was recording 1,400 d.b.h.p.; at 140 km.p.h. (87 m.p.h.), 1,340 d.b.h.p.; and at the top speed over this division of 144 km.p.h. (89·5 m.p.h.), 1,300 d.b.h.p. Going down the 1 in 200 from Survilliers, the engine accelerated to a peak of 146 km.p.h. (90·7 m.p.h.) just before Goussainville, where steam was shut off. When accelerating down this bank, the d.b.h.p. at a speed of 130 km.p.h. (80·7 m.p.h.) was 2,200. After steam was shut off, speed fell gradually to about 120 km.p.h. (74·6 m.p.h.) after 7 miles more of 1 in 200 down grade.

British and French Comparisons

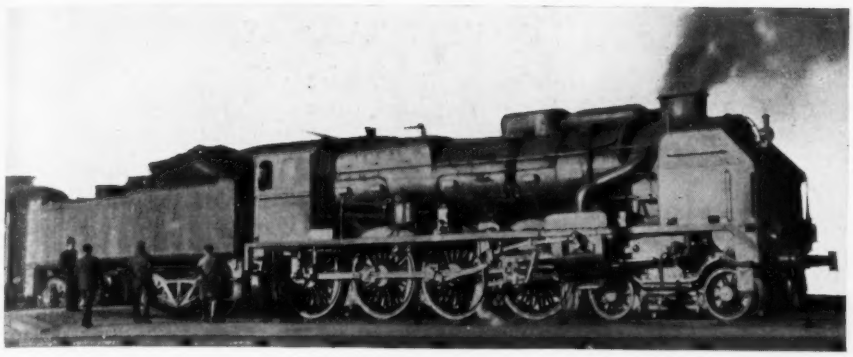
An interesting comparison can be made between this test run between Calais and Paris and the run of *Cock o' the North* from London to Barkston on the L.N.E.R. on June 19, 1934. From Calais Maritime to Amiens, 103½ miles, No. 4.707 took 85½ min. start to stop hauling 635 English tons, the average speed being 72·7 m.p.h. and the maximum 86·5 m.p.h., whereas *Cock o' the North* hauling 649 tons ran from King's Cross to Peterborough, 76·4 miles, in 81¾ min. inclusive of two bad checks, the average speed being 56·1 m.p.h. and the maximum slightly over 70. No attempt was made to push *Cock o' the North* on the easily graded sections, and when running downhill steam was mostly shut-off.

Comparing the 11-mile ascent at 1 in 200-178 from Essendine to Stoke, north of Peterborough, with the 12-mile climb at 1 in 200 to Survilliers, the English engine, with no greater cut-off than 30 per cent., maintained 56½-60 m.p.h. (commencing at 60 and topping the summit at 56½), whereas the French engine, working harder, maintained 68½-69½ m.p.h. on the lower part of the bank and 70-71 on the upper portion, the climb being commenced at 65 m.p.h. Up the 1 in 200 *Cock o' the North* was exerting 1,570-1,870 d.b.h.p. and on the 1 in 178, 1,800-1,935 d.b.h.p., with a peak of 2,090 when accelerating over a short intervening level section. No. 4.707's output rose gradually from 2,350 to 2,600 d.b.h.p. during the course of the ascent.

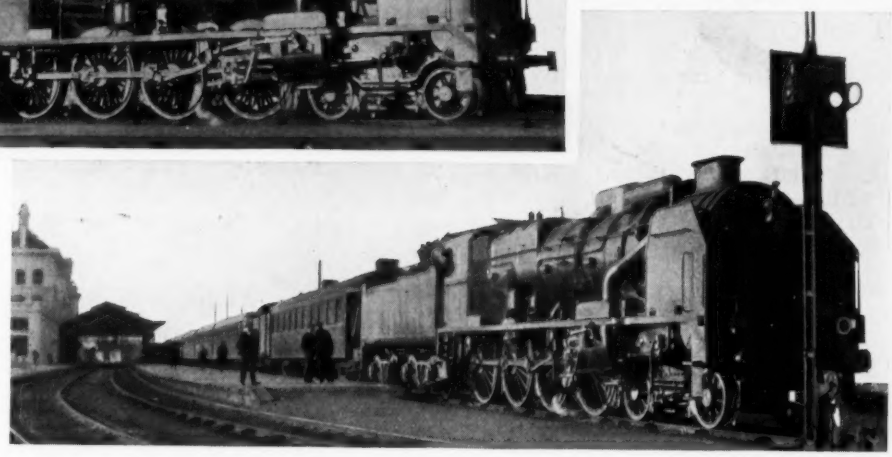
The French run right through from Calais to Paris confirmed what was a feature of another L.N.E.R. performance, viz., that exceptionally high speed schedules can be worked without unduly high maximum speed. On the occasion of the record run from King's Cross to Newcastle on March 5, the L.N.E.R. Pacific *Papyrus* averaged 68 m.p.h. over the 268½ miles with a maximum speed of 88½ m.p.h., and the French engine averaged 66·8 m.p.h., inclusive of a 9½-min. stop, (or 70·7 m.p.h. running average) over the 184 miles from Calais Maritime to La Chapelle with a maximum speed of 90¾ m.p.h. The coal consumption of the French engine, with a load three times as great as that of the Pacific, was approximately 89 lb. per mile, including heating the train, or twice as much as the consumption of *Papyrus*, although the calorific value was not so high. On the basis of grate area, the 4-8-0 was being fired at the rate of 145 lb. per sq. ft. of grate per hr., also corresponding to twice that of the L.N.E.R. Pacific.

Log of Test Run from Calais to Paris, February 19, 1935

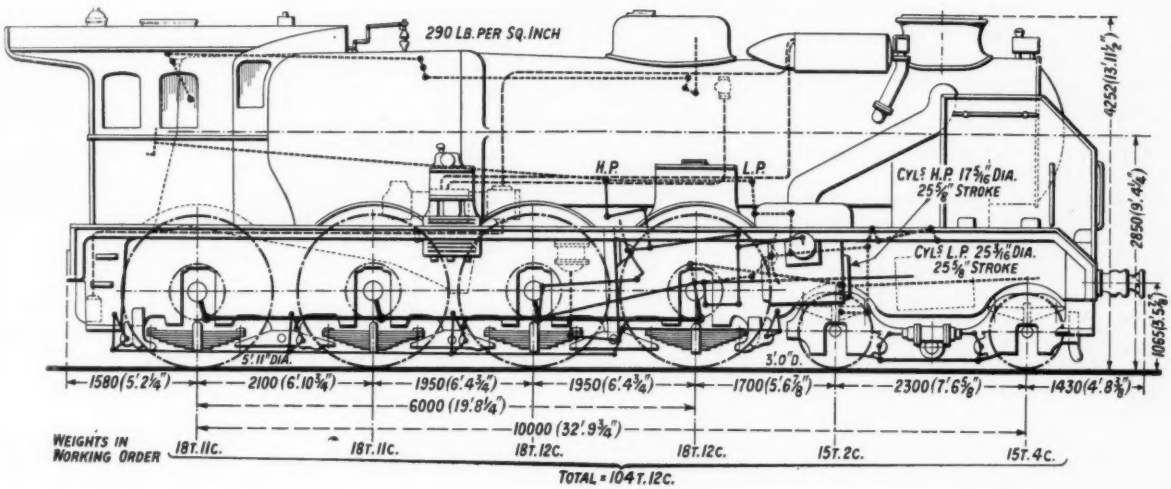
Distance,	Engine, P.O. 4-8-0, No. 4·707. Load, 646 tonnes (635 tonnes)		Time	
Miles			Min.	Sec.
0·00	Calais Maritime	dep.	0	00
1·6	Calais Ville	pass	3	33
2·9	Les Fontinettes	,,	4	58
6·2	Fréthun	,,	8	15
11·8	Caffiers	,,	14	20
16·9	Marquise	,,	18	45
23·3	Wimille–Wimereux	,,	23	40
26·2	Boulogne (Tintilleries)	,,	25	50
32·6	Hesdigneul	,,	31	30
36·7	*Km.* 238 (Neufchatel summit) ..	,,	34	20
44·0	Etaples	,,	39	55
51·0	Rang-du-Fliers-Verton	,,	45	10
61·0	Rue	,,	52	20
75·4	Abbeville	,,	63	20
90·5	Hangest	,,	74	50
97·6	Ailly-sur-Somme	,,	80	15
103·5	Amiens	arr.	85	32
		dep.	95	00
106·3	Longueau	pass	99	32
120·0	La Faloise	,,	110	50
130·2	Gannes	,,	118	57
135·1	St. Just	,,	122	30
144·2	Clermont	,,	128	47
153·2	Creil	,,	135	53
159·1	Chantilly	,,	141	00
163·0	Orry-la-Ville	,,	144	12
166·9	*Km.* 28 (Survilliers summit) ..	,,	147	00
172·3	Goussainville	,,	150	52
180·1	St. Denis	,,	157	25
184·0	La Chapelle	arr.	165	25

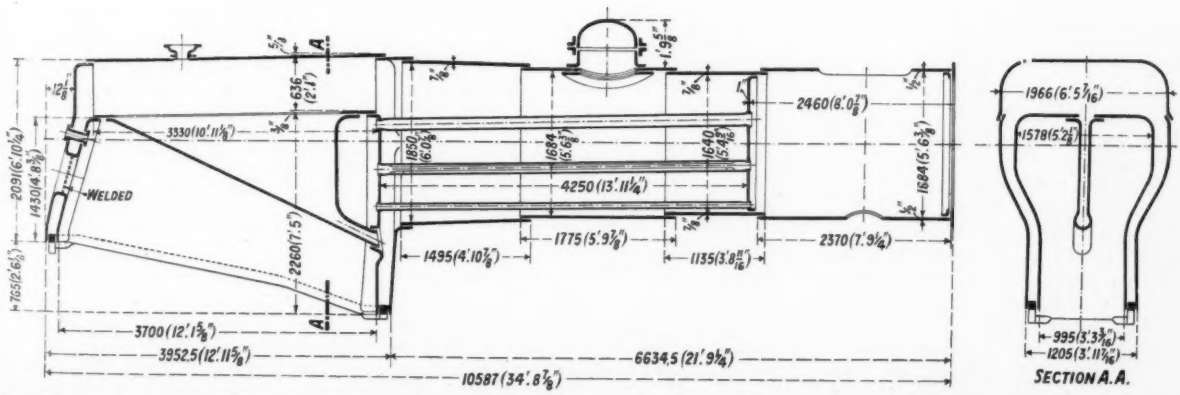


Left: P.O.-Midi 4-8-0 locomotive at the head of a 635-ton test train at Calais (Maritime). The new O.C.E.M. dynamometer car is immediately behind the Nord double-bogie tender which was fitted for the test



Right: P.O.-Midi 4-8-0 locomotive No. 4707 about to start from Calais (Maritime) on its 73-m.p.h. run to Paris





PARIS ORLEANS-MIDI RAILWAY 4-8-0 LOCOMOTIVE TESTED BETWEEN PARIS AND CALAIS

THE DINORWIC SLATE QUARRY RAILWAY

The largest slate quarries in the world, have about 60 miles of private railway lines

By C. F. CLEAVER, A.C.G.I.

THE Port Dinorwic Slate Quarries, at Llanberis, North Wales, are among the largest of their kind in the world, and in handling the huge output of slate, a complete and self-contained railway system, having two independent gauges, is involved. No fewer than 3,000 men are employed here on the production of 400 tons of finished slates a day, and to obtain this, about ten times that amount, or approximately 4,000 tons, of rock has to be blasted and removed.

The quarry itself consists of a mountain of practically solid rock, about 2,000 ft. high, and covering 700 acres, with a large deep lake at its foot. In quarrying the slate, the face of the mountain has been cut out into a series of 22 terraces, or galleries, as they are termed, running along the face of the mountain. The highest one is 1,500 ft. above the lake, which is itself 340 ft. above sea level. The rock is cut away by blasting and other means from the vertical faces of these galleries, and as the face of the lower gallery recedes from the side of the lake, leaving an extensive open space, a large pit, consisting of two galleries each 60 ft. deep, has been sunk in this space, and slate quarried out from below the level of the lake.

Each gallery has a separate railway system about 2 miles long, and these systems are connected together by inclines. The rails employed in the galleries are referred to as 2 ft. gauge, this being the distance between centres, but actually they are of the unusual 1 ft. $10\frac{3}{4}$ in. gauge. Each gallery contains a main line, over which the trucks are moved by steam locomotives, and branch lines leading to the face of the rock, and over these the trucks are moved by hand power. Where steam traction is used, the rails are of the bull head type, weighing 42 lb., and are set in cast-iron chairs, carried on wood sleepers, but where hand traction is used the rails consist of steel bars, 3 in. × $\frac{3}{4}$ in., set on edge and resting in notched sleepers. This form of construction renders it very easy to adapt the lines to the form of the quarry face, as they can readily be moved and bent to the required curves. The points themselves are of the fixed type, and consist of cast iron "V" shaped plates with suitably formed grooves. Over 50 miles of this gauge of line are laid throughout the quarry.

The first step in the production of slate is blasting out the rock. Holes, which as a rule are from 5 to 10 ft. long, but may be from 20 to 25 ft., are drilled into the face of the rock by air drills, to work which electrically-operated compressors are situated at various points in the quarry, and supply the drills through suitable pipe lines. Either black powder, of which no less than 90 tons is used each year, or gelignite, is employed. At certain fixed times of the day a signal is given, when all men retire to suitable shelters, and the fuses leading to the charges are ignited. When all the charges have been fired the men may return to their work, but if any charge fails to fire they are not allowed to leave the shelters for another half-hour.

After blasting, the broken rock is sorted into useful slate, and other matter, such as granite, which is not of any value. The stone, whether it be waste or good slate, is loaded up into steel trucks, open at one end to allow for tipping the material out, and these trucks, which each contain about two tons, are then hauled by hand on to the main line, where they are collected for subsequent removal by steam locomotive. An interesting point about this stock, the reason for which will be shown later, is that the axles are not of the usual type extending across the frame and carrying two wheels each, but each wheel is carried on a separate axle, running in two bearings, and the wheels themselves are fitted with flanges on both sides.

General view of pit, showing rails and ropeway

In the case of the pit referred to above, lines are laid at the bottom from the sides to the centre, and the trucks are lifted bodily up a ropeway and transferred to lines on the ground level, from which they are then moved on the narrow gauge line, as is done in the galleries. Scattered throughout the quarry are a series of "dressing sheds" where the slates are made, and the trucks of good material are taken by steam locomotives to these sheds, while the waste material is also taken in trains to tips on the bottom level, and dumped into the lake.

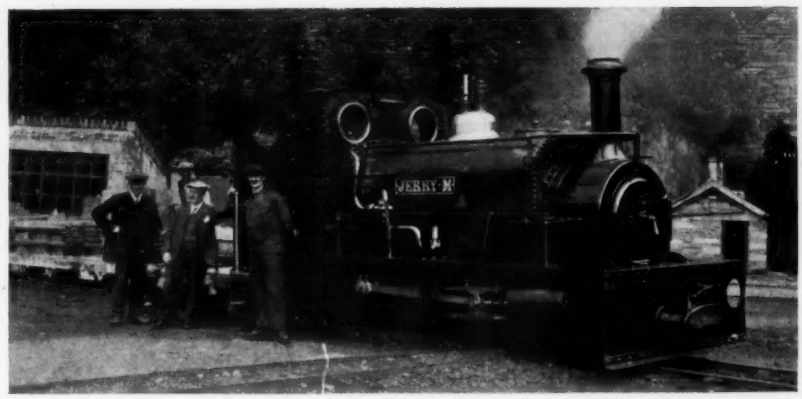
As explained earlier, the different galleries are connected together by inclines, and all material from the upper levels is taken down these to the lower levels, either in the form of waste, or as good material to the trimming sheds, or in the form of finished slates from the trimming sheds. These inclines, the grades of which are sometimes as steep as 1 in 2, have at the top a large drum, controlled by a band brake, and passing around the drum is a strong steel cable, one end of which is attached to the

loaded trucks at the top of the incline, and the other to the corresponding empty trucks at the bottom. On releasing the brake, the loaded trucks run down the incline by gravity, and haul up the empty ones, which are then returned to the quarry face. The rails used on the inclines are of 3-in. × 1-in. flat steel.

The 2-ft. gauge locomotives, of which 18 are employed in the galleries and two on the bottom level, were built by the Hunslet Engine Co. Ltd., Leeds. The first of these was supplied 40 years ago, and the balance at constant intervals until 1922, when the last two were delivered. The two locomotives used on the bottom level are slightly larger than the other 18. The dimensions are given below:—

	Galleries	Bottom Level
Type	0-4-0	0-4-0
Cylinders (2), diam.	7 in.	8½ in.
Piston stroke	10 in.	14 in.
Wheels, coupled, diam.	1 ft. 8 in.	2 ft. 2 in.
Rigid wheelbase	3 ft. 3 in.	4 ft. 6 in.
Height from rail to top of chimney	7 ft. 3 in.	7 ft. 10 in.
Extreme width	5 ft. 4 in.	6 ft.
Boiler, heating surfaces—		
Tubes	86 sq. ft.	171 sq. ft.
Firebox	14 sq. ft.	22 sq. ft.
Total	100 sq. ft.	193 sq. ft.
Grate area	2·5 sq. ft.	3·5 sq. ft.
Working pressure	160 lb. to sq. in.	130 lb. to sq. in.
Tank capacity	100 galls.	220 galls.
Fuel space	1½ cwt.	7 cu. ft.
Weight, empty	5 tons 19 cwt.	9 tons 5 cwt.
Weight in working order	6 tons 14 cwt.	10 tons 15 cwt.
Tractive effort at 75 per cent of boiler pressure	2,940 lb.	3,793 lb.
Ratio adhesive weight to tractive effort	5·1	6·3
Minimum radius of curve engine will traverse	21 ft.	40 ft.

The finished slates, after checking and counting, are loaded on to open-sided 2-ft. gauge trucks, the sides of which are built up of square bars of wood, held apart by cast-iron distance pieces, bolted through the floor of the truck. The wheels and axles of these trucks are as described above, with independent axles for each wheel. The quarry itself is about seven miles from Port Dinorwic, where the slates are finally loaded for transport either by sea or rail. The line from the quarry to the docks is of 4-ft. gauge. From the lower workings of the quarry the slates are taken in trainloads to a transfer dock, where the 2-ft. gauge trucks are loaded bodily on to the 4-ft. gauge trucks, without transfer of the slates.



2 ft. gauge locomotive "Jerry M"

A 4-ft. gauge truck consists of an ordinary four-wheeled unsprung wagon, having a frame bottom carrying two sets of 2-ft. gauge rails, each set accommodating two of the smaller trucks, making a total of four to a truck. In order to reduce the height of the centre of gravity of the load, the platform of the 4-ft. gauge truck is lowered, so that the wheels themselves protrude above the frame, and as the wheels and lines of the 2-ft. gauge straddle these wheels, the axles of the 2-ft. gauge trucks are independent, and do not extend across the truck, as explained previously. Automatic arrangements are provided both for locking the 4-ft. gauge trucks at the loading dock, and also for locking the smaller trucks on to the larger.

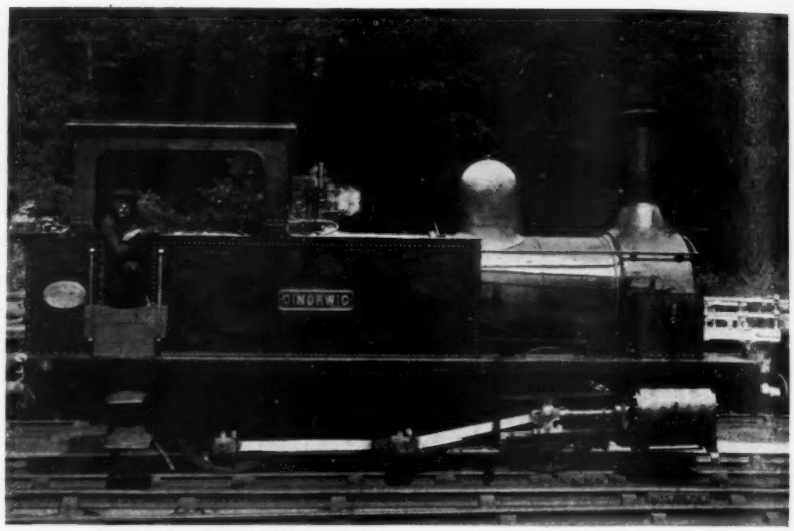
The brakes which are fitted on certain of the 4-ft. gauge trucks are of interest, as they consist of semi-circular steel bands, which actually operate on the upper half of the wheel tyres, their application being by a large pedal which can be operated from the floor of the truck, but as these vehicles are rebuilt or repaired, this type of brake is being replaced by the ordinary shoe type. When sufficient trucks have been loaded, a train is made up and taken down to Port Dinorwic. The average weight of slate in a train is 130 tons.

4 ft. gauge truck carrying two 2 ft. gauge trucks loaded with slate

The locomotives on the 4-ft. gauge line were supplied by the Hunslet Engine Co. Ltd., Leeds, and are of the 0-6-0 outside cylinder type, with side tanks. The stock consists of three locomotives for this gauge, one of which is in steam at a time, leaving one spare, and one to be under overhaul at any time. The latest addition to the 4-ft. gauge stock consists of a petrol locomotive supplied by Hardy Motors Limited, of Slough. The leading dimensions of the steam loco-

motives are as follow:—

Cylinders (2), diam. ..	12½ in.
Piston stroke	20 in.
Wheels, coupled, diam. ..	3 ft. 6 in.
Rigid wheelbase	10 ft.
Height from rail to top of chimney	11 ft. 8¼ in.
Extreme width	7 ft. 10¼ in.
Boiler, heating surfaces—	
Tubes	458 sq. ft.
Firebox	49 sq. ft.
Total	507 sq. ft.
Grate area	8 sq. ft.
Working pressure	140 lb. per sq. in.
Tank capacity	600 galls
Fuel capacity	1 ton.
Weight empty	21 tons 14 cwt.
Weight in working order ..	26 tons.
Maximum axle weight ..	9 tons 9 cwt.
Tractive effort at 75 per cent. of boiler pressure	7,812 lb.
Ratio of adhesive weight to tractive effort	7·5



4 ft. gauge locomotive "Dinorwic"

The petrol locomotive has a 4-cylinder engine, developing 55 b.h.p cooling for which is arranged by large tubular type radiators at both ends of the locomotive. Power is transmitted through a multi-disc clutch and reversing box to a four-speed gear-box, giving four speeds, of approximately 16, 8, 4, and 2·6 m.p.h. in either direction. The drive is taken through universally-jointed propeller shafts independently to the two axles, which are of the full floating bevel type.

Two independent brakes are fitted—a foot pedal operated band brake at the rear of the gear-box, and a screw-down hand brake operating through cast-iron shoes on all four wheels. A large cab, in which the driver stands facing across the locomotive, and thus has equal vision in either direction, is fitted, as well as ballast boxes, which increase the adhesion weight of the locomotive to 12 tons. At the rear end of the locomotive, underneath the frames, a winding drum is fitted, which can be operated from the engine in either direction, and carries 250 ft. of steel cable, while at the outer ends of the drum shaft two horizontal capstans are provided. Primarily, this locomotive is intended for emergency and breakdown work, but is also used for shunting and general purposes. All the locomotives, both steam and petrol, are painted in L.M.S. colours, viz.: crimson, with black edging and yellow lining.

The seven-mile 4-ft. gauge line from the quarry at Llanberis to Port Dinorwic is kept in a very excellent state of repair. The rails are of the bull-head type, weighing 84 lb. a yard, carried in cast-iron chairs on wood sleepers. No signalling is necessary, as only one engine is kept in steam at a time, but the level-crossing keepers on the line are advised of train movements by telephone, in order that they may warn road traffic of the approach of trains.

At Port Dinorwic the 2-ft. trucks are run off the larger ones, and are let down inclines about a quarter of a mile long to the dock itself, where the slates are transferred either to wagons on a branch of the L.M.S. Chester-Holyhead line, or are loaded on steamers for transport to Liverpool, or other docks, for shipment throughout the world. The company itself owns three steamers, one of which has a capacity of 300 tons of slates, and the other two capacities of 800 tons each.

4 ft. gauge petrol locomotive with train of slates

All the work of maintenance of locomotives and rolling-stock, as well as the building of new wagons, and other incidental work is carried out by the company itself, which has extensive workshops at the quarry, comprising a wood-working shop with all necessary machinery, fitting shop, machine shop, blacksmiths' shop, having eight forges and two power hammers, and a foundry where all rail crossings, chairs, axle-boxes, and other parts are made. At the present time, power for these shops is obtained from a water turbine supplied from a reservoir on the Snowdon range of mountains, and this has only recently replaced a very fine water wheel of 50 ft. 5 in. dia. and 5 ft. 3 in. wide, which was erected in 1870,

and has a capacity of 80 h.p. This wheel is now being repaired, and will be put into use again as soon as is necessary.

Electric power for lighting the quarry, and for operating the machines scattered throughout the workings, is supplied by the North Wales Power Company; the current comes in at a voltage of 10,000, and is transformed down to 500 for power and 200 for lighting, in two sub-stations at the quarry. Great care is taken in the examination of rolling-stock, and every truck after return from Port Dinorwic is carefully examined before being allowed to pass up the inclines again into the quarry. If a truck shows any defect it is run into a special shop, where it is turned over on a tumbler for more thorough and convenient examination.

In addition to the goods traffic of the railway there is also passenger traffic, as a workmen's train is run up from Port Dinorwic to Llanberis each morning, and returns in the evening. An interesting point is that coaches are slipped at various points on the line on the night trip and picked up again in the morning, so that they form waiting rooms for the men who join the train at intermediate points. The passenger stock consists of 23 coaches, each having seating capacity for 60 men, and a station with covered-in platform is provided at the quarry, forming a carriage shed for the coaches during the day.

Historically, the quarry and railway system are of great interest, as the quarry was first exploited over a century and a half ago. Unfortunately, the exact date when the rails were laid down is not known, but the railway was certainly in operation before the Chester-Holyhead line of the late L.N.W.R. was laid, and this would no doubt account for the unusual gauge of 4 ft.

In the museum at the quarry one or two interesting examples of early stock are preserved. One consists of a locomotive, the name-plate of which reads: "A Horlock & Co., North Fleet Iron Works, Kent, 1848." This locomotive is of the four-coupled type, having a four-wheeled tender, with a low-pitched boiler and a tall chimney. The cylinders, set at an angle to the axle, are mounted alongside the smokebox, and drive the second axle, which is coupled to the front one. Although the cylinders drive the trailing axle, the eccentrics operating the valves are mounted on the leading axle, the expansion links being suspended from the front end of the firebox; the valves, which are on top of the cylinders, are operated by means of rocking levers and rods.

Examples of the early velocipedes, which were used by the men for coming to work, are also shown, and are of the treadle-operated and hand-operated varieties. These were, however, found very unsatisfactory and dangerous, as the different gangs of men used to race one another along the line, and if a man lost control of his crank handle, nasty accidents were liable to occur.

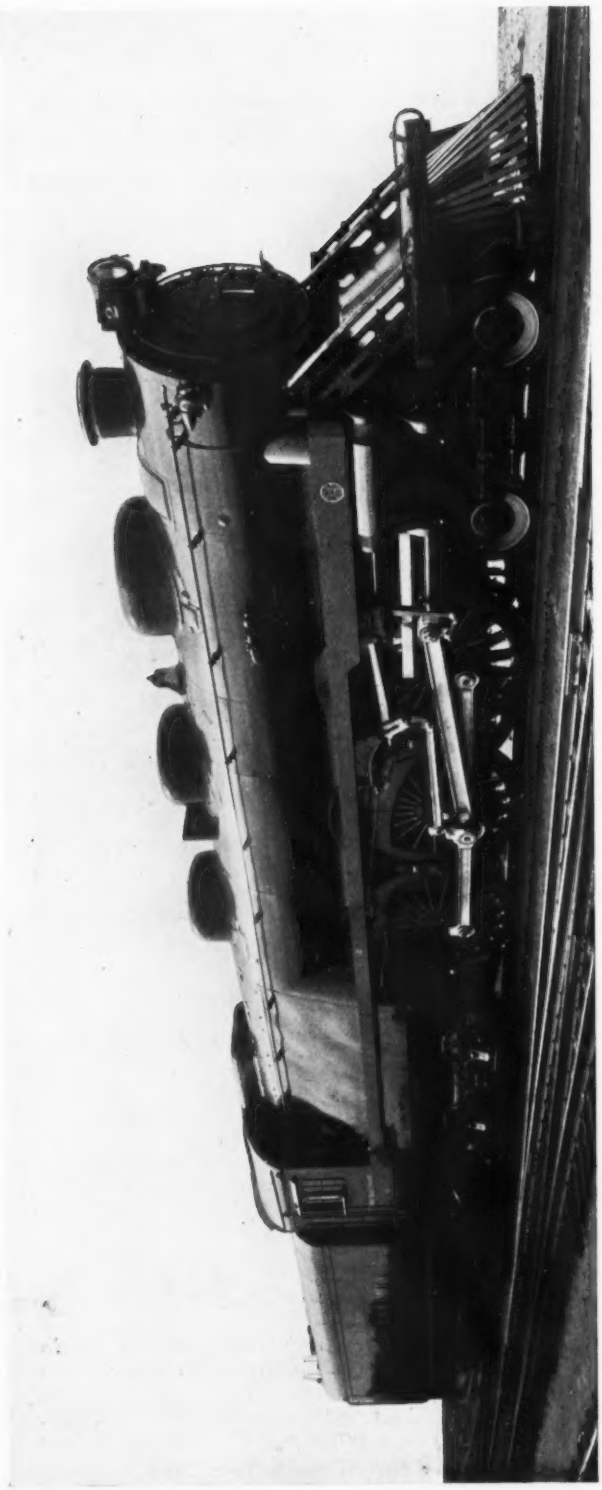
In conclusion, the writer wishes to express his thanks to Mr. T. Lloyd Williams, the Manager of the quarry, for allowing this article to be written, and to Mr. J. Williams, the very able all-round Engineer of the quarry, who kindly conducted the writer round and supplied the necessary information.

Crossing the Chappar Rift

An impressive scene on the North West Frontier of India, showing a train from Quetta to Sibi descending the 1 *in* 45 *Sind-Pishin section of the North Western Railway at the moment of crossing the Margaret Louise bridge over the famous Chappar Rift in Baluchistan. The main span of the bridge is* 230 *ft. above the bottom of the rift and the engine is an "XA" class, the lightest* (13-*ton axle load*) *of the Indian standard* 4-6-2 *types*

THE LATEST BALTIMORE & OHIO HIGH-SPEED LOCOMOTIVE

This design incorporates the 4-6-4 wheel arrangement, 7 ft. 0 in. coupled wheels, and a high-pressure boiler



ON pages 200-201 of the issue of THE RAILWAY GAZETTE dated February 1, there appeared a short illustrated article dealing with the 4-4-4 type lightweight high-speed locomotive completed during the latter part of last year at the Mount Clare shops of the Baltimore & Ohio Railroad Company, and it was then stated that another similar engine, but with the 4-6-4 wheel arrangement was in course of construction at the same shops. This has since been completed, and we are now, by the courtesy of Mr. George H. Emerson, the company's Chief of Motive Power and Equipment, able to reproduce a photograph of the locomotive and briefly describe its main features. As in the previous case the engine, which is partly streamlined, is equipped with a boiler of the combined fire and water-tube pattern, carrying a steam pressure of 350 lb. per sq. in., and although coupled wheels of 7 ft. 0 in. diameter are used the boiler has been placed as low as possible in order to obtain a low centre of gravity above the rails. A lightweight booster engine is fitted to the trailing bogie to assist in smooth handling of trains at starting and for aiding acceleration.

The equipment of the locomotive follows closely that of the 4-4-4 type previously described. It includes a mechanical stoker, a steel superheater header with rolled-in units, vestibule cab, mechanical lubricator and driving axleboxes with adjustable quarter brasses. The front end is arranged with a concealed coupler, and the axleboxes of the tender have roller bearings. The tender is fitted with a water pick-up scoop and an air pump, reservoirs and electric lighting generator. The cylinders are placed outside the frames with the piston valves above them and driving the middle pair of coupled wheels, steam distribution being effected by means of Walschaerts motion.

The following are the leading particulars:—

Cylinders, dia.	19 in.
,, piston stroke	28 in.
Wheels, coupled, dia.	7 ft. 0 in.
Boiler, steam pressure	350 lb. per sq. in.
,, heating surface, firebox	612 sq. ft.
,, tubes and flues	2,727 sq. ft.
,, ,, ,, total	3,339 sq. ft.
Superheater	720 sq. ft.
Combined total	4,059 sq. ft.
Grate area	61·75 sq. ft.
Weight of engine in working order	131 tons 5 cwt. (long)
,, engine and tender	220 tons 9 cwt. (long)
Tractive force (without booster and at limited cut off)	34,000 lb.
Tractive force (with booster)	41,000 lb.
Cylinder h.p.	2,200
Boiler capacity (Cole ratios)	121 per cent.

The eight-wheeled tender carries 16 short tons of coal and 10,000 gallons of water.

The locomotive bears the numbe: 2, classification V-2 and is named *Lord Baltimore*. It will be remembered that the 4-4-4 type locomotive was named *Lady Baltimore*. Both engines are painted a pleasing shade of blue to match the new aluminium streamlined trains specially built for the new high speed passenger service.

Mr. Emerson informs us that the 4-6-4 locomotive has made some special test runs and has been handling some of the company's fast trains between Baltimore, Md., Washington, D.C., and Philadelphia, and indications are that it will fully meet requirements.

RAILWAY NEWS SECTION

PERSONAL

Sir Cyril Hurcombe, K.B.E., C.B., Secretary of the Ministry of Transport, has accepted the invitation of the Council of the Institute of Transport to become President of the Institute for the year beginning October 1, 1935.

We note with regret the death on April 10, of Mr. H. R. Kempe, M.Inst. C.E., M.I.Mech.E., M.I.E.E., well known to engineers for his valuable "Engineer's Year Book." Mr. Kempe, who was 83 years of age, was educated at Westminster School and King's College, London, where he specialised in electrical work. He afterwards joined the Engineering Branch of the Post Office, and eventually became Principal Technical Officer and Electrician, the post from which he retired in 1913. He was the author of an "Electrical Engineer's Pocket Book"; "Alternating Currents" and "A Handbook of Electrical Testing." His "Engineer's Year Book" is one of the most comprehensive books of reference—it comprises over 2,500 pages—for the desk of the civil, mechanical, and electrical engineer alike.

Mr. A. W. Bolden, Chairman of Antofagasta (Chili) and Bolivia Railway Company and the Nitrate Railways Company, has joined the board of Latin American Investment Trust.

Commander W. B. Clementson, R.D., R.N.R., Marine Superintendent, Goole Steam Shipping, L.M.S.R., has been elected a member of the Court of the Honourable Company of Master Mariners.

Mr. Arthur Andrews, Managing Director of Drummond (Sales) Limited, Birmingham, and a Director of Drummond Brothers Limited, Guildford, has joined the board of directors of William Asquith Limited, and will take special interest in the sales policy and arrangements of that company. This new arrangement has been made possible by the retirement of William Asquith Limited from the sales organisation run by Associated British Machine Tool Makers Limited.

INDIAN RAILWAY STAFF CHANGES

Mr. R. C. Ivey has been appointed to officiate as Deputy Transportation Superintendent, G.I.P.R., as from January 19.

Mr. H. H. Yule has been appointed to officiate as Chief Commercial Manager, E.I.R., as from February 9.

Mr. F. A. De la Noujerede has been appointed to officiate as Controller of Stores, E.B.R., as from February 13.

Mr. W. Hood, Deputy Chief Engineer, Bridges, G.I.P.R., has been granted 9½ months' leave as from February 11.

Mr. A. K. Homan, Divisional Superintendent, N.W.R., has been granted eight months' leave as from March 22.

Mr. H. J. Romer, Deputy Transportation Superintendent, G.I.P.R., has been granted two years' leave preparatory to retirement.

Mr. A. F. Harvey, Officiating Chief Engineer, E.B.R., has been appointed to officiate as Agent as from March 2.

Mr. R. B. Seth has been appointed to officiate as Government Inspector of Railways, Circle No. 2, Calcutta, as from March 2.

Rai Bahadur N. C. Ghosh, has been appointed to officiate as Divisional Superintendent, E.I.R., as from February 9.

Mr. L. E. Vining, Deputy Chief Operating Superintendent, E.I.R., has been granted seven months' leave, as from March 13.

Lt.-Col. W. Macrae, R.E., Chief Engineer, N.W.R., has been granted leave preparatory to retirement for about two months as from April 1.

Mr. A. Hastie has been appointed to officiate as Deputy Chief Engineer, Bridges, G.I.P.R., as from February 11.

Mr. N. W. Porteous, of the Chief Mechanical Engineer's Department, Egyptian State Railways, is proceeding, about April 15, on leave preparatory

(*Continued on page* 741)

The full-sized copy of the "Rocket" which has been placed in the Science Museum, South Kensington (see news article on page 741). *Mr. Hore-Belisha at the unveiling ceremony*

Right: A view in the attractive new buffet bar for travellers which has been arranged adjacent to the concourse of St. Pancras station, L.M.S.R.

Left: The interior of one of the new first class restaurant cars now running on the L.N.E.R. Anglo-Scottish services. The impression of space conveyed by the interior decoration, to which we referred in an editorial note last week, is apparent in this view

to retirement. At the expiry of his leave he will proceed to India to take up the position of Assistant Locomotive Superintendent, H.E.H. The Nizam's State Railway.

FUNERAL OF MR. F. C. COLEMAN

The funeral of Mr. F. C. Coleman, Managing Director of our contemporary *Modern Transport*, whose death in Cape Town we announced in our issue of March 15, took place at Esher Parish Church on Saturday last, April 13. In addition to Mrs. Coleman and family mourners, Mr. William Black, Mr. D. R. Lamb, Editor, and other members of the staff of *Modern Transport*, there were present :—

Mr. E. O. Norton (representing the Periodical Trade Press and Weekly Newspaper Proprietors' Association); Sir H. Osborne Mance; Sir Robert Evans; Mr. T. Bernard Hare (also representing Mr. T. H. Hornsby, Divisional General Manager, North Eastern Area, L.N.E.R.); Mr. J. A. Kay, Editor, THE RAILWAY GAZETTE; Mr. E. W. Willis, Editor, *World's Carriers*; Mr. C. H. Haywood, Editor, *Motor Transport*; Mr. W. J. Sedcole (also representing Mr. G. H. Griffith, Pullman Car Co. Ltd.); Mr. A. Winter Gray, Secretary, Institute of Transport; Major C. E. Williams (representing the Institution of Locomotive Engineers); Mr. Julian S. Tritton (representing Messrs. Rendel, Palmer & Tritton); Mr. L. J. LeClair (also representing the Westinghouse Brake & Signal Co. Ltd.); Mr. J. Walter Beaumont (also representing the Sentinel Waggon Works Limited); Mr. A. W. J. Talbot; Miss Blackshaw (representing Mr. A. Norman Davis, the Cleveland Bridge & Engineering Co. Ltd.); Mr. A. J. Pearson; Mr. Robert G. MacIver; Mr. Edward Evans; and Mr. Isaac (Odhams Press Limited).

We learn with regret of the death, on April 13, of Sir William Marwood, K.C.B., who from 1919-23 was Director-General of Public Safety and General Purposes at the Ministry of Transport. Sir William was born in 1863, educated at Tonbridge, and took his degree as eighteenth wrangler at Cambridge in 1884. After service in the Post Office he was transferred to the Board of Trade in 1892, where he was later Secretary to the committees on wear of rails, means of communication between passengers and guards, and the vibration caused by the working of the Central London Railway. He became Secretary of the Railway Department in 1909, and Joint Permanent Secretary in 1919, in which year he was also appointed Director General as stated above: he retired in 1923. Sir William was made a C.B. in 1912 and a K.C.B. in 1917, and in 1928 he was appointed chairman of a committee on railway traffic in Ireland.

French Locomotive Trials

After the first pages of this issue had gone to press it was noticed that the gradients of Caffiers Bank, on the main line between Calais and Boulogne had been erroneously shown on the diagram on page 730 as 1 in 222 instead of the 1 in 125 correctly specified in the text. These remarks also apply to the grades marked 1 in 222 from Caffiers to Boulogne.

The "Rocket" Facsimile at South Kensington

Unveiling Ceremony at the Science Museum by the Minister of Transport—Details of the original "Rocket"

On Thursday of last week, as briefly recorded on page 711 in our issue of April 12, Mr. Hore-Belisha, M.P. Minister of Transport, unveiled the full-size facsimile of the *Rocket* recently built by Robert Stephenson & Co. Ltd. for the Science Museum, South Kensington. Mr. H. Ramsbotham, M.P., Parliamentary Secretary to the Board of Education, presided.

Among those who accepted invitations to attend the ceremony were :—

Mr. W. A. Agnew, Mrs. Allan (descendant), Messrs. G. H. Loftus Allen, J. S. Anderson, J. Auld, W. S. Graff Baker, V. M. Barrington-Ward, Sir William J. Berry, Messrs. A. F. Bound, H. Leslie Boyce, M.P., O. Bulleid, E. M. Bywell, Major W. H. Carver, M.P., Messrs. H. Chambers, Alan E. L. Chorlton, M.P., V. R. Bowen Cooke, A. R. Cooper, O. H. Corble, F. Crews.

Prof. William E. Dalby, Mr. C. G. G. Dandridge, The Mayor of Darlington, Messrs. A. W. Donaldson, A. A. M. Durrant, A. Feirn, A. P. M. Fleming, Sir Henry Fowler, Sir Richard T. Glazebrook, Messrs. A. Winter Gray, I. S. W. Groom, Thomas Hardie, F. A. Harper, Captain J. W. Harris, Major H. A. Harrison, Brig.-Gen. Sir H. Hartley, Messrs. F. W. Hawksworth, J. Henderson, R. H. Hill, T. Hornbuckle, Sir Cyril Hurcomb, Prof. C. E. Inglis, Messrs. H. G. Ivatt, A. C. Kirkus.

Messrs. D. V. Levien, J. Marchbank, E. G. Marsden, C. F. Dendy Marshall, A. V. Mason, R. E. L. Maunsell, J. H. Millen, W. M. Mordey, Lt.-Col. A. H. L. Mount, Sir Christopher T. R. Needham, The Lord Mayor of Newcastle-on-Tyne, Lord Palmer, Sir William B. Peat, Messrs. Loughnan St. L. Pendred, John Phillimore, J. Purves.

Sir Richard Redmayne, Sir Hugh Reid, Messrs. R. A. Riddles, C. J. Selway, G. N. Shawcross, J. Shearman, C. E. R. Sherrington, Sir John D. Siddeley, Messrs. Roger T. Smith, W. A. Stanier, C. M. Stedman, S. J. Symes, J. S. Tritton, Sir Seymour B. Tritton, Messrs. W. K. Wallace, R. H. Whitelegg, Major C. E. Williams, Messrs. W. Wood, W. E. Yates.

In addition there were many representatives of Robert Stephenson & Co. Ltd., the Institute of Mechanical Engineers, the Institute of Locomotive Engineers, and the Newcomen Society.

Before unveiling the model, Mr. Hore-Belisha said that at the ceremony which inaugurated the first appearance of the *Rocket* on the Manchester & Liverpool Railway, Mr. Huskisson, M.P., was run over and killed. As a one-time President of the Board of Trade, he was responsible for transport. His untimely death might have stimulated the conscience of Parliament to provide that the development of the new form of transport, which the *Rocket* portended, would be accompanied and safeguarded at every stage by adequate precautions for the public safety. Thus it had come about that the numerous and all-embracing regulations which governed the movement of traffic on rails were not regarded as restrictions but improvements and guarantees of efficiency and security. Had a similar foresight been shown in the generation on which the boon of the motor car was first conferred, the nation would have been spared the material, the economic, and the personal loss which the weekly casualty lists published by the Ministry of Transport miserably and monotonously revealed.

As it is, they were trying to make good rapidly, and, he feared, sometimes abruptly, the omissions of forty years. The measures and devices which they were now forced to institute, had they proceeded *pari-passu* with the growth in the number of mechanically-propelled vehicles on the roads, would have been accepted as natural. Now they had to be superimposed on an established mode of transport. Perhaps what was being done on the roads would be seen to be part of a reasoned plan if they considered, in the presence of the *Rocket*, what had been done on the railways. Traffic on the latter was originally controlled like traffic upon the roads by policemen with the familiar truncheon and brassard. The memory of that still survived in the minds of old railwaymen, who referred to the signalman as the "bobby." This manual method gave way on the railways, as it was now giving way on the roads, to elaborate mechanical and electrical signals. One-way traffic, by-passing, fly over junctions—all these were railway devices which the highway engineer was now adapting. His latest plagiarism was the barriers which were being put up to protect pedestrians from wandering on to the carriageway. The certificating of drivers, and the construction requirements affecting the fitting of brakes were also learned from railway practice.*

It was under the ægis of such precautions as these that the railways from the days of the *Rocket* to the day of the streamlined Jubilee Express, which was to do the 270 miles between London and Newcastle in four hours, had developed. And yet, what was remarkable was that the essentials of the *Rocket* were still embodied in modern locomotives. The three principles which remained unchanged were the tubular boiler; the direct action of connecting rods on the driving wheels; and the direction of the exhaust up the chimney. The *Rocket* demonstrated its capacity in a trial run competition with two other engines. Today, he imagined, it would have been sent like the *Cock o' the North*, to the new testing station at Vitry in France to enable its operation at high speed under scientific conditions to be studied. Why had we, he asked, in the home of railway construction, in the country which produced the *Rocket*, no national testing station for railway engines?

A short account of the construction of the *Rocket* was then given by Lord Daryngton, a Director of Robert Stephenson & Co. Ltd., while Major C. E. Williams

* We deal with this same aspect of the road safety question in the first editorial note of this issue—ED. *R.G.*

added some brief remarks upon the development of the steam locomotive during the last century. A vote of thanks to Mr. Hore-Belisha was then proposed by Col. E. E. B. Mackintosh, Director of the Science Museum.

The original "Rocket"

The original engine was built to compete at the Rainhill trials in October, 1829, perhaps the most important event in early locomotive history, and was entered by George and Robert Stephenson and Henry Booth. The success of the *Rocket*, which won the premium of £500 offered by the directors of the Liverpool & Manchester Railway for the most improved locomotive engine constructed in accordance with certain conditions, definitely proved the suitability of the locomotive as a means of general railway haulage, and showed that speeds hitherto unapproached could be attained. Its success was due mainly to the adoption of the tubular boiler which was suggested to George Stephenson by Booth, who was Secretary and Treasurer of the Liverpool & Manchester Railway Company. George Stephenson is popularly credited with the design of the *Rocket*, and its actual construction, at Newcastle, was carried out by his son Robert, the father's time being fully occupied with the making of the railway itself.

At the trials, on October 8, 1829, the *Rocket*, with a load equal to three times its own weight, completed its two 35-mile journeys in 3 hr. 10 min. and 2 hr. 52 min. respectively. Its average speed, over the central portion of the course, was 13·8 m.p.h., and the maximum speed, for one trip, was 24·1 m.p.h. When running light, however, it attained a speed of 29 m.p.h. The water consumption was 114 gall. an hour and the coke consumption was 217 lb. an hour. The *Rocket* was the only engine to complete the journeys and to fulfil all the conditions, and was, therefore, awarded the premium. It was purchased for £550 by the Liverpool & Manchester Railway and, after some alteration, worked on that line for 6 years. At the opening of the railway on September 15, 1830, it ran over and fatally injured the Right Hon. William Huskisson, then M.P. for Liverpool. This accident, however, drew attention to the great possibilities of travelling by steam, as George Stephenson took the injured man to his destination, 11 miles away, at a speed of 36 m.p.h.

As far as can be ascertained, the cylinders were lowered to their nearly horizontal position late in 1831, but prior to this a complete smokebox and a shorter chimney had been fitted. In 1836 the *Rocket* was sold to Thompson & Co., of Kirkhouse, near Carlisle, for £300, and worked on the Midgeholme Railway until 1844. In 1838 it is said to have covered a distance of four miles in four minutes. In 1851 it was sent to Newcastle to be prepared for showing at the Great Exhibition in London of that year, but this intention was not carried out, and the engine remained at Newcastle until 1862, when it was presented to the Patent Office Museum by Thompson & Co. By this time the engine had lost many of its parts, especially those made of brass or copper; these deficiencies, combined with the alterations that had been made, render the present appearance of the engine very different from that of 1829.

The *Rocket* was a four-wheel single-driving engine, with its cylinders fastened to plates on the boiler and inclined downward at an angle of 35 degrees, so as to drive crank pins on the front wheels. The cylinders were 8 in. diam. by 17 in. stroke, and the driving wheels were 56·5 in. diam. The trailing wheels were 30 in. diam. and the wheelbase was 86 in. The driving wheels were of oak, with cast-iron bosses and wrought-iron tyres, while the trailing wheels were of cast-iron. Both axles were provided with springs. The boiler barrel was 40 in. diam. by 6 ft. long and contained 25 copper tubes, 3 in. inside diam. The heating surface was 138 sq. ft. and the grate area 6 sq. ft.

The firebox was formed with dry front and back plates, and the top and sides were formed by a pair of copper plates pinched together all round and riveted, leaving a water space of 3 in. between them. The plates were stayed together at 3 in. intervals and the two sides were tied together at the bottom by four bars, on which the firebars rested. The firebox water space was connected with the barrel by pipes at the top and bottom. The working steam pressure was 50 lb. per sq. in., and a mercurial gauge indicated the pressure from 45 to 60 lb. Two safety valves were provided, one loaded by a weighted lever and the other by springs. The exhaust steam passed into the chimney, which was 15 ft. high, by two pipes fitted with nozzles 1·5 in. diam. The tender was a wooden truck with four cast-iron wheels 33 in. diam. It carried a barrel holding 300 gal. of water. The engine weighed 4·25 tons in working order, of which 2·5 tons rested on the driving wheels; the tender weighed 3·2 tons.

At Rainhill the *Rocket* was painted yellow and black with a white chimney, the intention, as stated by Robert Stephenson, being to make the engine look light.

The track on which the engine stands is also a reproduction of the original. The rails were of wrought iron, of T section, rolled in 15 ft. lengths and weighing 35 lb. a yard; the webs were of fish-belly form in five spans of 3 ft. The cast-iron chairs weighed 15 lb. each, and the rails were secured in them by a side rib on the web and by iron keys on the outer side of the rail. At the joints, the adjacent rail ends were keyed together in one chair. The sleepers used on embankments were split trees of larch or oak about 10 in. diam. and 9 ft. long, and to these the chairs were fixed by two iron spikes. In cuttings stone block sleepers were used.

Railways in Relation to Industry

An address by Mr. W. V. Wood, a Vice-President, L.M.S.R.

In a speech to the Imperial Industries Club on April 9 (referred to in an editorial note on page 717 this week) Mr. W. V. Wood, Vice-President, Finance and Service Departments, L.M.S.R., outlined the situation affecting the railways in the discharge of their functions to the industrial life of the country. Tracing the development of this form of transport, Mr. Wood remarked that railway construction in England had cost more than had usually been the case with similar lengths abroad owing to the absence of State aid, the high cost of land in localities which had already been developed, and various other factors.

In the present century, motor transport had become a most economical form of conveyance owing to progress with the internal combustion engine, cheap rubber, and tar bound roads. Road hauliers, too, enjoyed an additional advantage over the railways, whose rates were raised and further regulated by the Act of 1921, in their freedom to charge as they wished. Moreover, they were not bound to cater for all classes of traffic and could therefore select that which was most remunerative.

Such inequality of treatment, Mr. Wood considered, was bound to effect a gradual lowering of railway rates for the higher grade traffics, and it would therefore either be necessary to revise the whole railway rating structure so as to give the companies the same freedom as their competitors, or to subject road hauliers to comparable regulation. The present situation burdened railway stockholders unfairly and tended to reduce facilities. Complete freedom of charging for both parties would effect too violent an upheaval in industries, so that the problem of adapting the present system by extending control to the roads would have to be faced.

Mr. Wood then explained that the railways have to devote 70 per cent. of their income to maintenance alone, quite apart from the requirements of moving traffic. The loss of the more remunerative classes of goods was therefore particularly serious.

The value of the railways to industry as large customers was demonstrated by the fact that they spent £14 million a year on coal. If they ceased to make these purchases—owing to electrification for example—the loss to the industry would be sufficient to put up the price of coal for the general con-

sumer by about 1s. 6d. a ton. The iron and steel industries, too, were at present assured a steady home demand by the 800,000 tons required annually by the railways, a fact which assisted to offset the effect of variations in export trade.

Mr. Wood concluded his speech by suggesting that the position of the railways in respect to road transport was comparable to that of the Post Office if it had to operate next door to a mail carrying agency allowed by Parliament to occupy premises free of rates and taxes, and able to fix its own charges and to select for conveyance what postal packages it wished. In such a case, the government would undoubtedly take steps to protect the interests of its comprehensive transport system.

A discussion followed the paper, and in replying to various speakers Mr. Wood quoted figures to show what the railways were doing to modernise their undertakings, and what extensive service was provided at rates far lower than could be adopted by road hauliers. Since the grouping, the L.M.S.R. had spent £52 million on rolling stock and another £52 million on new works. Over 500 million miles of passenger traffic on that company were represented by workmen's tickets at fares averaging less than ½d. a mile. The returns on season ticket journeys were even lower. Three farthings a mile was now the average fare for all classes of passenger traffic, a steady diminution having taken place since government possession ceased. The average charge per mile for all classes of merchandise traffic was now about 1½d. per ton, including coal at 1d. per ton.

RAILWAY AND OTHER MEETINGS

MANSION HOUSE ASSOCIATION ON TRANSPORT (Inc.)

The annual general meeting of the Mansion House Association on Transport (Incorporated) was held at Caxton Hall, Westminster, S.W.1, on April 12, with Mr. W. H. Gaunt, O.B.E., M.Inst.T. (the President) in the chair.

The Honorary Secretary (Mr. E. A. Hilder) read the notice convening the meeting.

Before the chairman moved the adoption of the report and accounts, Sir Isidore Salmon, M.P., Chairman of the association's Parliamentary Committee, dealt in a short speech with the operation of the Road and Rail Traffic Act of 1933. As large users of motor transport, members of the association wanted to retain the right of saying whether they would send their products by road, rail or canal. It was, he said, the duty of a Government to legislate but not to administrate—to advise but not to plan. Industry suffered from too many regulations.

The chairman, in moving the adoption of the report and accounts, first reviewed the activities of the association twenty-five years ago, when it was viewing with some apprehension the projected amalgamations of certain railways in England, Scotland and South Wales. He considered that railways today had a very different attitude towards the interests of traders, who in turn had possessed more cohesive channels of approach to the companies since the Railways Act of 1921. The association now regarded transport agencies on land, air and water as essential elements in the production and sale of raw and manufactured commodities, with an important influence on the position occupied by this country among the industrial nations.

The chairman then discussed some points arising out of the Road & Rail Traffic Act of 1933 and criticised the granting of licences to road hauliers by area authorities with a possibly insular outlook. Goods traffic was hard to confine to scheduled routes and was much affected by fluctuations in the ebb and flow of general trade. Although he did not suggest that it would be desirable to have free lance operators picking up loads indiscriminately at whatever rates they could get, he thought the association did not wish to see the railways alone benefiting from an industrial revival. He hoped that the licensing authorities would issue reports showing the transport situation in their respective areas so that the available facilities could be correlated with the demand from a national rather than a regional standpoint. The appropriate authority to review and act upon these reports was doubtless the Transport Advisory Council.

He considered that many of the agreed rail charges approved during the year had been arrived at by an aggregation of the charges divided by the tonnage, so that the total tonnage might be carried by train at a lower rate than in the past. Some traders who were not in a position to offer road tonnage, however, thought that the companies had not been anxious to grant them agreed charges. Others, who had a proportion of road-borne traffic, seemed to have encountered unwillingness to negotiate regarding the rail section even though it was a separate entity.

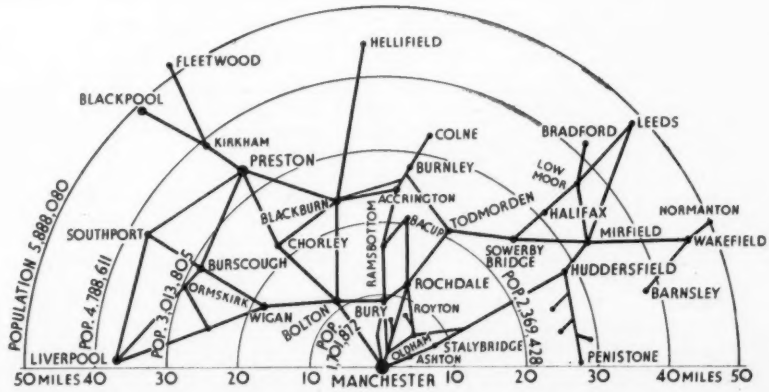
The strengthening of bridges, both on rail and road was a question of urgency which needed more adequate treatment than it at present received. It was a national problem and should be tackled on a national scale. During the year, the association had continued to co-operate with the Coastal Trade Development Council, and it was satisfactory to note that coastwise traffic had shown a steady improvement over recent years. Traffic on the Thames and road safety were other matters which had engaged the association's attention, and the board looked forward to the continued support of members in a time of improving trade and better understanding between transport users and providers.

The report and accounts were unanimously adopted.

Britain's Busiest Railway Area

A survey of operating features in the Central Division of the L.M.S.R. by Mr. J. H. Robinson (Divisional Superintendent of Operation, Manchester), appeared under the heading, " Britain's Busiest Railway Area " in the April issue of *On Time* (see page 677 of our issue of April 12).

It was illustrated by the sketch map which we reproduce, showing the extraordinary concentration of population in the closely situated industrial towns



within a 50-mile radius of Manchester. A great variety of manufacturing and distributive trades, and no fewer than 1,761 cotton mills, are sources of traffic which the Central Division has to handle under unusually complicated conditions.

The Pennine range and its spurs lie between many of the towns, so that severe gradients and tunnels abound. Permanent speed restrictions, too, number 873, of which 50 per cent. are for 20 m.p.h. or less. These, as well as the numerous pitfall slowings inevitable in colliery areas, are an obstacle to main line as well as branch services. The profusion of large industrial centres has caused a railway network to be built up serving 342 passenger stations and having 736 signal-boxes, of which every third controls a junction. A train mileage budget of 31,000,000 is calculated for 1935, comprising 16½ million coaching miles and 14¾ freight train miles. Some 18,000 more trains than in 1933 were operated last year, and if the revival of trade continues, a further increase is in prospect.

In spite of all these factors, the Central Division ranks second only to the Northern Division in its standard of express train punctuality, while of its five intensely active local train districts two are in Division I of the L.M.S. Punctuality League and the remaining three, in Division II, all exceeded the stipulated 1,000 points during the month to February 23 last.

Small Steel Refrigerator Car

Recently a new type of small steel refrigerator car has been introduced in the United States for handling perishable food products. It has a capacity of ten tons, and the insulated construction is so thorough that the ice consumption is only thirteen pounds an hour to maintain sixty degrees. The car is also designed so that satisfactory insulating conditions may be easily maintained. By removing a few lines of bolts along the sides, the entire outer steel shell may be lifted from the frame.

RAILWAY AND OTHER REPORTS

Churchill Machine Tool Co. Ltd.—A dividend of 6 per cent. is being paid on the preference shares on account of arrears.

Madras & Southern Mahratta.—An interim dividend will be paid on July 1 of 4½ per cent., comprising 1¾ per cent. carrying the interest and 2¾ per cent. from stockholders' revenue account. This is the same rate as that for the corresponding period of last year.

King's Lynn Dock and Railway.—A credit balance on net revenue for 1934 of £3,523 is shown after payment of debenture interest. A full dividend on the 4 per cent. preference stock (1869) and 2 per cent. on the consolidated preference stock will leave £253 to be carried forward.

Zafra & Huelva Railway.—Although gross traffic receipts of Ptas. 3,461,861 during 1934 showed a slight increase, this was discounted by a rise in the operating ratio from 112·98 to 113·23 per cent., and the net result was a loss of Ptas. 524,891. Over the past four years the loss has totalled Ptas. 1,779,722, and it is again impossible to make any distribution to the first mortgage bondholders either by way of interest or redemption. The report states that the company was not allowed by the Government to carry out necessary economies, and that it was compelled to give its workshop staff six days' pay for every five days' work. A claim by the Government on the railway for tax at 7·5 per cent., amounting to Ptas. 99,580, on the difference between the face value of the first mortgage bonds and the sums distributed in redemption from 1927-30, is *sub judice*.

National Railways of Mexico.—Net operating revenues for 1934 increased from $10,105,408 to $27,677,987, of which traffic receipts accounted for $104,211,822 as against $81,815,366. Expenses rose only by $4,823,878 to $76,533,835, so that their proportion to revenue fell from 87·65 to 73·44 per cent. A net balance for the year of $24,898,659 compared with one of $7,968,375 in 1933.

Devon General Omnibus & Touring Co. Ltd.—This company is jointly controlled by the British Electric Traction group, (50 per cent.) and the Great Western Railway (30 per cent.), and Southern Railway (20 per cent.). The profit for the year 1934, after providing for depreciation, was £73,549, Adding £2,872 balance from the previous year makes a total of £76,421. The directors recommend that £35,545 be transferred to general reserve, a dividend on preference shares for the year (£10,500), and a dividend on ordinary shares of 12½ per cent. (25,000), leaving £5,376 to be carried forward. The goodwill of the Torquay Tramways Co. Ltd. has been acquired, and the services formerly provided by that company have, since the beginning of 1934, been operated by the Devon General Company, which now owns a fleet of 217 omnibuses and coaches.

Mansion House Association on Transport.—The 53rd annual report of the executive committee for 1934 shows that during the year the council and committees of the association held in all 34 meetings. Membership was maintained at a substantial level, and the upward tendency observed towards the end of 1933 has been continued. The allegiance of a number of new firms has added to the council the services of several keen members of the younger generation of industrial transport officers. The President (Mr. W. H. Gaunt, O.B.E., M.Inst.T.) has continued to serve as representative of trading interests on the Transport Advisory Council created by the Minister of Transport under Part 3 of the Road and Rail Traffic Act, 1933. He has also been appointed to serve on the new Road Safety Committee set up to advise the Minister. A wide range of subjects connected with railway and road transport, as well as Parliamentary matters connected with all firms of transport, has continued to receive attention. An account of the annual general meeting of the association is given on p. 743.

CONTRACTS AND TENDERS

S. Fox & Co. Ltd. has received an order from the Bengal-Nagpur Railway for 100 steel carriage and wagon axles.

Airvac Limited has received an order from the Birmingham Railway Carriage & Wagon Co. Ltd., for 352 Airvac ventilators and interior fittings. These are to be fitted to the steel roofs of sleeping cars for the Canton-Hankow Railway and arranged so that the double cavities will be ventilated simultaneously with the interior of the cars.

Airvac Limited has also received a repeat order for 90 Airvacs for the Finnish State Railways.

Nasmyth Wilson & Co. Ltd. has received an order for seven sets of connecting rods and 14 crank-pins for the Bengal-Nagpur Railway.

The Controller of Stores, Great Indian Peninsula Railway, has placed orders as follow :—

Kilburn & Co.: 14 Gross of copper rivets to be manufactured by the Ohio Brass Co. Ltd.
United Engineering Corporation: 104 Gross brass set screws to be manufactured by Guest, Keen & Nettlefolds Limited.
Precious Electric Co. Ltd.: Quantity of track bonds and copper strips to be manufactured by Hitachi Limited, Tokyo.
Electro Mechanics Limited: Quantity of track bonds, to be manufactured by Felten & Guilleaune.
Greaves, Cotton & Co. Ltd.: Quantity of track bonds and brass set screws to be manufactured by British Insulated Cables Limited.
Marker, Goldsteane & Co.: Copper cables and strips to be manufactured by Furukwa Electric Co. Ltd., Tokyo.
Gillanders, Arbuthnot & Co. and Allwyn Steel Equipment Co. Ltd., respectively: Steel bins and steel cupboards.

Leyland Motors Limited has received orders from Western S.M.T. Co. Ltd. and W. Alexander & Son, each for one oil-engined Tiger vehicle.

The Crown Agents for the Colonies have recently placed the following orders :—

Chloride Electrical Storage Co. Ltd.: Accumulator boxes.
J. Wilkes Sons & Mapplebeck Limited and Howell & Co. Ltd.: Boiler tubes.
Pease & Partners Limited: Brake blocks.
J. Blakeborough & Sons Ltd.: Cast-iron piping.
Butters Bros. & Co. and Cowans, Sheldon & Co. Ltd.: Cranes.
The Newbury Diesel Co. Ltd.: Diesel engine.
Ruston-Bucyrus Limited: Electrical excavators.
Vacuum Oil Co. Ltd.: Lubricating oil.
P. & W. MacLellan Limited: Mild steel bars.
Dorman, Long & Co. Ltd.: Rails and fishplates.
C. Richards & Sons Ltd.: Rivets.
Telegraph Condenser Co. Ltd.: Static condensers.
Johnson & Phillips Limited: Static transformers.
Stewarts and Lloyds Limited: Steel pipes.
J. Stone & Co. Ltd.: Train-lighting spares.
Phosphor Bronze Co. Ltd.: White metal.

The Egyptian State Railways Administration has placed the following orders :—

P. & W. MacLellan Limited: Mild steel. (Ref E.S.R. 1.191, total price £252 17s. 1d.).
Metal Traders Limited: Antimony (Ref. E.S.R. 6.111, total price £838 1s. 11d.).
Mathews & Yates Limited: Ventilating plant (Ref. (E.S.R. 13-222, total price £208).
H. J. Skelton & Co. Ltd.: Galvanised plain sheets (Ref. E.S.R. 1.180, total price £600).
Fried Krupp: Carriage and wagon tyres (Ref. E.S.R. 21.260, total price £2,862 10s.).
W. F. Dennis & Co. and Vereinigte Deutsche Metallwerke: Wire.
Thos. Hinshelwood & Co. Ltd.: Knotting (Ref. E.S.R. 60.114, total price £247 18s. 4d.).

Owen & Dyson Limited has received an order for 300 rolled steel disc wheels for the Bengal-Nagpur Railway.

The British Thomson-Houston Co. Ltd. has received from the L.N.E.R. a part contract for the supply of Mazda lamps for twelve months ending April 30, 1936.

Metropolitan-Vickers Electrical Co. Ltd. has also secured a part contract from the L.N.E.R. for Cosmos electric lamps for the twelve months ending April 30, 1936.

Egyptian Enquiries

The Egyptian State Railways Administration invites tenders, receivable at the General Management, Cairo, by the dates named, as follow :—

10—1,250 metric tons screw spikes for track (April 24).
800—2,400 metric tons flat-bottomed rails (April 30).
60,000—100,000 steel sleepers and accessories (May 4).
15,000 boiler tubes (May 8).
Three or four replacement locomotive boilers (May 18).

Tenders will also be received at the Chief Inspecting Engineer's Office, London, by April 25, for 45 steel tyres, 2 ft. $11\frac{5}{16}$ in. diam., for steel box trucks, and on a date to be published later for two step-up transformers; also at the Office of the Superintendent of Stores, Cairo, by April 30, for the supply of garage machine tools, comprising electric test bench, bus elevator, engine hydraulic tester, and engine stands.

The Agent, East Indian Railway, has placed orders with the Kumardhubi Engineering Works for 3,625 cast steel axleboxes at Rs. 14.14 each, and with Burn & Co. Ltd. for 5,725 axlebox slippers at Rs. 1.12 each.

The South Indian Railway invites tenders, to be received by May 3, for the supply of two transformers, 250 kVA, 11,000-3,300 volt, for outdoor service in India. Specifications and forms of tender are available at the company's offices, 91, Petty France, Westminster, S.W.1.

The South African Railways and Harbours Administration is calling for tenders, to be presented in Johannesburg by May 20, for the supply of brake and clutch linings for road vehicles. Firms desirous of offering brake linings of United Kingdom manufacture can obtain further details from the Department of Overseas Trade.

German Locomotive Works Transferred

The Borsig Lokomotiv-Werke G.m.b.H. announces the transfer of its workshops and offices from Berlin-Tegel to Hennigsdorf (Osthavelland), near Berlin-Tegel, and as from April 12 all Borsig locomotives will be manufactured there. Mr. J. Clubley Armstrong, of 131, Victoria Street, Westminster, is London agent for this firm.

Drummond (Sales) Limited has been appointed sole agent for William Asquith Limited for Birmingham and Midlands territory, and, in addition, sole agent for all users connected with the motor trade, covering makers of motor cars, motor lorries, motor cycles, aeroplanes, and components and accessories for these products. This new arrangement has been made possible by the retirement of William Asquith Limited from the sales organisation run by Associated British Machine Tool Makers Limited.

The Lithuanian Ministry of Communications has appointed May 9 as the date for receiving tenders for the supply of 50,000 tons of locomotive coal, to be delivered c.i.f. Klaipeda (Memel), Lithuania. The quality must conform to the technical conditions laid down by the Lithuanian Ministry of Communications. Offers should be sent to the Lithuanian Legation, 10, Palace Gate, Kensington, London, W.8.

Thos. W. Ward Limited announces that the Nottingham factory of Metropolitan-Cammell Carriage & Wagon Company, covering about 13 acres, has been acquired by them. It is not known whether this factory will be dismantled, but it is hoped some industry will take over these excellent buildings.

80-m.p.h. Schedules in Germany.—Owing to delay in completion of the diesel units which are to operate the high speed services described in last week's issue, it is understood that, although shown in the May 15 edition of the Reichbahn timetables, they will not actually be run until the diesel units are available. Consideration is also being given to the use on certain of the runs of streamlined high-speed steam units.

Steam or Diesel for Railways?—The Crewe Engineering Apprentices' Society, in conjunction with the C.T.C. Engineering Society, on March 30, at Crewe, debated whether diesel traction should supersede steam on the railways. Mr. J. Smith, M.B.E., A.M.I.C.E., was in the chair. Mr. H. D. Welch, in the affirmative, claimed that diesels were more economical in operation, due to low fuel consumption and high thermal efficiency. He supported this claim by quoting figures for the Burlington Zephyr (as recorded in THE RAILWAY GAZETTE *Diesel Railway Traction Supplement* of March 22), and stated that high-speed light-weight, streamlined diesels showed an immediate traffic increase over the steam services they displaced. Mr. S. Wise, defending the steam locomotive, asserted that it was as capable of high speeds as the diesel, and quoted the recent L.N.E.R. record runs. He also maintained that a large amount of the power developed in diesels was wasted in the transmission system. Mr. Whitelegg, supporting the case for the oil engine, claimed that oil could be obtained from coal, thus evading the necessity of importing fuel. Mr. Balt denied that diesels were more reliable than steam and spoke of diesel failures due to torsional vibration and other causes. The general opinion appeared to be that the margin of economy obtained in oil engines did not warrant the expense of a general change-over.

NOTES AND NEWS

G.W.R. Act, 1935.—The Royal Assent was given on April 11 to the Great Western Railway Act, 1935. This is an omnibus measure of which the principal part relates to the stabilisation of canal charges.

Spanish Night Services.—Second-class sleeping cars have been introduced recently by the Madrid, Saragossa & Alicante Railway on the night trains between Madrid, Alicante and Cartagena, Madrid and Zaragossa, and Madrid and Badajoz.

French Locomotive Tests.—After a series of trials with 650 and 750-ton passenger trains between Paris, Boulogne, and Calais, on the Nord, the 4-8-0 express locomotive No. 4.707 of the P.O.-Midi has been tested on the Paris-Cherbourg route of the Etat. Hauling a train of 600 tonnes, No. 4.707 covered the 230 miles from St. Lazare to Cherbourg in 3 hr. 32 min. including a stop of 10 min. at Caen, and two slacks to 10 m.p.h., giving an end-to-end speed of 65 m.p.h. The route includes long grades as steep as 1 in 111.

Brussels Termini and the Junction Railway.—At the meeting of the Board of the Belgian National Railways, yesterday, the plans for the alterations to be made to the Brussels-Nord and Brussels-Midi stations were examined, both in the event of the Nord-Midi Junction line being realised and in the event of this scheme being abandoned. The board confirmed its previous decision to contribute towards the junction railway to the extent to which they would have borne the cost of remodelling the two stations if the link between them were not carried out. Finally, a special commission was appointed, including four directors of the National Railways, to study these schemes thoroughly and to report to the board.

L.N.E.R. Station Reconstruction.—An extensive scheme for the modernisation and improvement of Dovercourt Bay station is to be put in hand immediately by the L.N.E.R. The existing booking office will be converted into a booking hali, and a modern booking office will take the place of the present combined booking hall and waiting room. Careful consideration is being given to the decorative scheme, and an electric illuminated sign will be a prominent feature on the exterior of the station. Also, the L.N.E.R. is shortly to undertake a scheme of improvement at Welwyn Garden City station. To provide easier access for passengers to and from the east side of the line, a 6-ft. footpath is to be provided in connection with the existing footbridge and the roadway in the goods yard. In addition, a passimeter booking office is to be installed so that passengers approaching the station from the eastern side of the line will be able to obtain their tickets without having to cross the railway to the existing booking office on the other side.

Electric Light at Thorpe-le-Soken Station.—The L.N.E.R. has decided to install electric lighting at Thorpe-le-Soken station, an important junction for the lines from Clacton and Walton-on-the-Naze.

Steel Castings for General Engineering Purposes.—A B.S. specification for steel castings for general engineering purposes (B.S.S. No. 592—1935) has just been issued, and may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 2d., post free.

Progress of Railway Bills.—A select Committee of the House of Commons has been appointed to begin the consideration on May 1 of the E Group of Private Bills which includes those of the Southern Railway and the London Passenger Transport Board. The first day of the meeting of the Committee will be devoted to the South Essex Waterworks Bill. The Chairman is Sir Henry Cautley. With the withdrawal of the petition by owners and occupiers of property abutting on the Grantham Canal, the London & North Eastern Railway Bill is now unopposed in the House of Commons.

Southern Railway Rating.—The Railway and Canal Commission, on April 15, delivered its reserved decision in appeals relating to part of the value roll of the Southern Railway. These concerned offices, shops, &c., let at Victoria station, and offices let at Beckenham Junction goods yard; certain departmental offices at London Bridge, Waterloo, and Southampton; high tension cables and substations. The Court decided that the premises in question at Victoria and Beckenham had been correctly included in the roll; that the high tension cables and substations should be included in the roll; and that the departmental offices were ancillary and should not be included in the roll.

R.A.S. Isle of Man Air Service.—The new Isle of Man air service, which is being operated by Railway Air Services Limited on behalf of the L.M.S.R. and the Isle of Man Steam Packet Co. Ltd. jointly, commenced operation on April 15, when two services were provided in each direction daily between Manchester (Barton), Blackpool (Squires Gate) and the Isle of Man (Ronaldsway). These services, which afford connection at Barton with the R.A.S. trunk service between London, Birmingham, Manchester, Liverpool, Belfast, and Glasgow, and is being maintained by D.H. 84 (Dragon) machines, each seating six passengers. The journey time is approximately an hour in each direction. A through service is later to be introduced between Liverpool (Speke), Blackpool, and the Isle of Man

Economic Aspect of Railway Signalling.—Owing to a printer's error the name of Mr. W. L. Box, General Manager and Engineer of the Liverpool Overhead Railway was wrongly spelt in our notice last week of the paper entitled as above by Mr. A. J. Pearson of the L.M.S.R,, Euston.

A Malarial Control Course for Engineers.—Beginning on Monday, July 1 next, a course upon the control of malaria will be held at the Ross Institute of Tropical Hygiene, Keppel Street, Gower Street, London, W.C.1. The course, which will last for five days, and will be under Sir Malcolm Watson, Director of the Institute, is for construction and other engineers in charge of labour in the tropics, but will also be of interest to laymen proceeding to malarial countries. The course is free, but applications to attend should be sent to the Organising Secretary at the Institute.

London Transport Acquisitions.—The London Passenger Transport Arbitration Tribunal gave its award on April 9 in two claims against the London Passenger Transport Board in respect of two undertakings transferred. The first claim—for £64,000—was that of the Renown Traction Co. Ltd., which ran services in East Ham and also a service between East Ham and Ladbroke Grove. In this case the total amount awarded was £29,772. The second claim was that of the Ryan Transport Company, a private undertaking, which asked for £24,099 in equal amounts of A, B, and C Transport stock. The award in this case was for a total sum of £8,204.

Rubber in Transport.—A series of three papers on the preparation and uses of rubber has been read recently to the Royal Society of Arts, the last of which, given by Mr. Colin Macbeth, M.I.A.E., M.S.A.E., F.I.R.I., on April 15 dealt with the material as applied to transport. Among the qualities of rubber tyres to which he referred was that of promoting riding comfort by providing a controlled but yielding wheel periphery which limits vertical accelerations of the axle. The coming of steam traction stimulated a general demand for rapid transport which rubber supplied by making first the bicycle and then the motor-car practicable means of travel for all. Mr. Macbeth mentioned that the railways were large users of rubber for drawbar and buffing purposes, and that the application of the cord tyre to railway vehicles was seen in the Micheline railcar, with which it was hoped to revive branch line passenger traffic by providing more attractive and faster services.

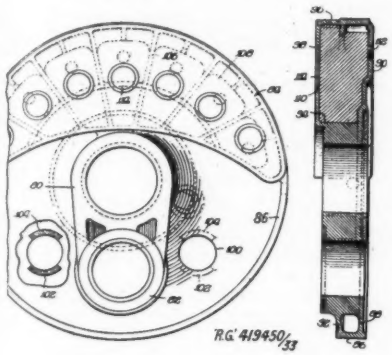
In view of the Easter holidays, this issue of THE RAILWAY GAZETTE *is published three days earlier than usual, and consequently the tables of British and foreign railway traffic returns are held over until next week.*

ABSTRACTS OF RECENT PATENTS*

No. 419,450. Locomotive Wheels

H. E. Doerr, of 6700, *Manchester Avenue, City of St. Louis, Missouri, U.S.A. May* 2, 1933. (*Convention Date*: *May* 13, 1932.)

A locomotive wheel or the like is formed with substantially continuous spaced webs, extending between the rim portion and the main and crank-pin hubs thereof, which are pierced with openings so positioned as to be

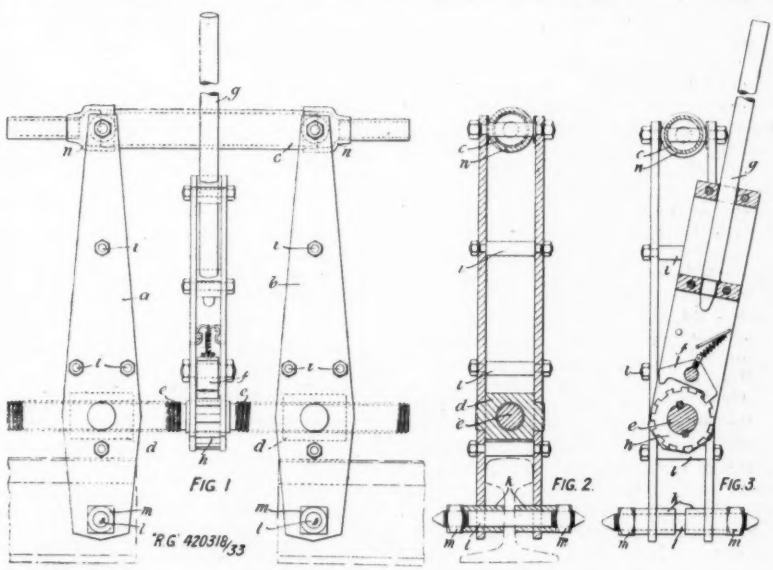


movable to coincide with the pins of the driving mechanism for the wheel, so that the pins may be removed through the openings. A driving wheel for a locomotive comprises a main hub 80, a crank pin hub 82, a counter-balance pocket 84 and a rim portion 86. Extending between the hubs 80 and 82 and the rim portion 86 is a web 88 having a portion 90 forming one of the walls of the counter-balance pocket 84. Spaced in relation to the web 88 and extending between the main hub 80 and counter-balance pocket 84, as well as between the hubs 80 and 82 and the rim portion 86 is a second web 92 which terminates in a transverse wall 94 of the pocket 84. The counter-balance pocket 84 is further formed with an oppositely disposed wall 96 formed integral with the rim 86 and has a wall 98 spaced in opposite relation to the wall 90. The spaced webs 88 and 92 are formed with oppositely disposed openings 100 to provide suitable space whereby a cross-head pin may be backed therethrough when it is desired to remove one or more elements of the driving means associated therewith. The openings 100 also serve to provide means whereby the core forming material between the spaced webs may be removed, and the webs may be suitably reinforced adjacent to these openings by means of the spaced walls 102 and 104 extending between the webs, these walls being disposed in spaced relation to provide an opening for passage of this core forming material. A plurality of webs 106 are provided for reinforcing the walls 90 and 98 of the counter-balance pocket, the webs extending between these walls and being radially disposed between the walls 94 and 96 to form a plurality of compartments 108. The core forming material within these compartments is removed therefrom through openings 110 in the wall 98 and lead may be introduced therein through openings 112. The openings 110 may be closed by closure plates 114.—(*Accepted November* 2, 1934.)

No. 420,318. Rail-adjusting Devices

The Hydraulic Engineering Co. Ltd., and N. B. Ellington, both of Charles Street, Chester, Cheshire. July 7, 1933.

In a device for adjusting the expansion gap between adjacent rails as may be required from time to time due to the variation in the gap by "rail creep" or other causes, the load is applied by a right- and left-handed screw located above the rails and engaging nuts on which are pivoted members transferring the load to pins or the like passing through the rails. The apparatus is formed with two double link members *a*, *b*, connected at their upper ends by means of a tube *c*. Each double link member carries a trunnion block *d* having an internally threaded aperture therein so that each block forms a nut, and the respective nuts are adapted to be engaged by right- and left-hand screw-threaded parts of a spindle *e* having means by which the screw-threaded member may be rotated in one direction or the other. In the construction shown, the rotation is effected by a pawl *f* carried by an operating lever *g* and co-operating with a ratchet wheel *h* on the spindle. The two parts of each double link member are separated by means of distance pieces *i* so that their lower ends may pass over the head of a rail as shown in Fig. 2, and at the bottom of each double link member apertures are provided through which may be passed bushes *k* surrounding a bolt *l* adapted to be passed through a fish-plate hole in the rail, the bushes being tightened against each side of the rail web by means of nuts *m* upon the outer ends of the bolt. The bolts *l* thus constitute the means by which the load of the nut and screw mechanism is transferred to the rails, and the arrangement is such that when the rail has been freed by knocking out the keys the rails may be moved *in situ* towards or away from one another, according to the direction of rotation of the screw-threaded member. The length of the distance pieces *i* is sufficient to enable the apparatus to be used with varying sizes of rail, and the bushes *k* are provided so that when the nuts *m* are tightened in position, the bolt *l* is materially relieved of the bending moment that would come upon it if a simple bolt were employed. The tube *c* may be screwed into end sockets *n* forming handles for facilitating the manipulation of the device and its adjustment relatively to the rails.—(*Accepted November* 29, 1934.)



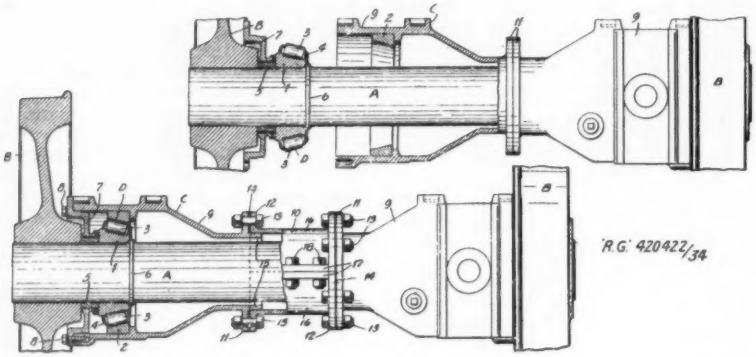
No. 420,422. Axle Housings

The Timken Roller-Bearing Company, of Denber Avenue, Canton, Ohio, U.S.A., June 13, 1934. (*Convention date*: *July* 7, 1933.)

A sectional stationary housing for roller bearing or anti-friction bearing axles comprises separate end sections

* These abridgments of recently published specifications are specially compiled for THE RAILWAY GAZETTE by permission of the Controllor of His Majesty's Stationery Office. Group abridgments can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, either sheet by sheet as issued, on payment of a subscription of 5s. a group volume, or in bound volumes, price 2s. each, and the full specifications can be obtained from the same address price 1s. each.

and a removable intermediate section disposed between the ends and positively connected thereto. A roller bearing railway car axle construction comprises an axle A having wheels B and an axle housing C of the inboard type. Interposed between A and each end of C is a taper roller bearing D arranged with the small ends of its bearings facing inwardly and comprising an inner raceway member 1, an outer raceway member 2 mounted in the housing, and a series of taper roller



bearings 3 interposed between the raceway members and held in place on the inner member by a cage 4. A spacing sleeve 5 is mounted on the axle A between the cone 1 and the hub of the wheel B and holds the cone against a rib 6. A closure ring 7 is removably secured to the end of the axle housing by means of cap screws 8 and serves to close the annular space between the sleeve 5 and the housing. The axle housing C is made in three sections, namely, two end sections 9 and an intermediate section 10. The adjacent ends of each end section 9 and the intermediate section 10 are provided with co-operating outstanding flanges 11 and 12, respectively, that are removably secured together by bolts 13, a shim 14 being interposed between said flanges for adjusting the bearing. The sections are held in axial alignment by means of an extension 15 at the inner end of each end section, which extension has a snug fit in the intermediate section. The intermediate section 10 is split lengthwise in the plane of the axis of the axle housing to form two separable parts 16. Flanges 17 extend along the edges of the split between said parts and are secured together by bolts 18. The removal of the end closure screws 8 and the bolts 13 and 18 permits the intermediate section 10 of the housing C to be removed from the axle A, and the end sections 9 to be drawn inwardly far enough to expose the roller bearings D. The cups remain seated in the end sections, where their bearing faces may be easily inspected. Thus all parts of the bearings may be inspected without removing the wheels or end sections from the axle and the parts may be easily restored to their original position.—(*Accepted November* 30, 1934.)

COMPLETE SPECIFICATIONS ACCEPTED

417,594. Steam-heating systems for steam-driven locomotives. Guy, H. L., and Associated Electrical Industries Limited.

417,729. Regulator-valve apparatus for locomotive and like engines. Superheater Co. Ltd. and Boyes, F. A.

417,616. Railway sleepers. British Insulated Cables Limited, Wilson, L. B., United Steel Cos. Ltd., and Mason, B. G.

417,883. Soot blowers for boilers and like apparatus. Turner, C. S.

417,623. Steam locomotives. Soc. Anon. Locomotive à Vapore Franco.

417,891. Journal lubricators. Cunningham, H. B., Tucker, J. W., Sliger, F. A., Eaton, W. H., and Michael, W. C.

417,818. Tyre for rail vehicles. Hirshfeld, C. F.

417,745. De-ballasting machine for railways. Guilbert, P. L., and Legrand, J.

417,768. Taper roller bearings. Skerrett, H. N.

417,844. Suspension of railway cars and other rail vehicles. Bugatti, J.

418,084. Steam traps. Hopkinsons Limited and Brown, R. L.

418,097. Bogies for railway cars. Ihlem, A.

418,446. Packing for a rotating shaft relatively to the housing journalling said shaft, more particularly an oil-tight and dust-tight packing for the axle-bearings of rail vehicles. Malcher, B.

418,451. Steam and like valves. Hopkinsons Limited, Brown, R. L., and Sewell, G.

419,149. Track-actuated train control apparatus. Hasler Akt. Ges. Vorm. Telegraphen-Werkstatte von G. Hasler.

419,399. Systems for the communication of control or signal influences, more particularly for centralised traffic-controlling installations for railways. General Railway Signal Company.

419,524. Signalling arrangements for level crossings. Vereinigte Eisenbahn-Signal-Werke Ges.

419,451. Wheels for railway cars, locomotives, or the like. Doerr, H. E.

419,674. Rail bearer plates or railway sleepers. May, C. R.

419,464. Lubrication of railway and like axleboxes. Whitelegg, R. H.

419,630. Automatically reclosing circuit-breaker systems for use on electric railways. British Thomson-Houston Co. Ltd.

419,491. Axle bearings for railway vehicles. Hanl, A.

419,695. Locomotive crossheads. Timken Roller Bearing Company.

420,096. Draw-bar couplings for railway and other vehicles. Gloucester Railway Carriage & Wagon Co. Ltd., and Willans, G. H.

420,381. Vacuum braking apparatus. Brown, D. F., Cadman, N. G., and Westinghouse Brake & Saxby Signal Co. Ltd.

420,190. Machine for measuring and machining frames and underframes of vehicles, especially railway bogies. Muller, L., Schwering, F., and Werkzeugmaschinen-Fabrik Gildemeister & Co. Akt. Ges.

420,193. Arrangements for safeguarding crossings on railway lines. Naamlooze Vennootschap Machinerieen-en Apparaten Fabrieken.

420,256. Apparatus for measuring the forces acting between two elements of a railway vehicle. Mauzin, A. E., and Langevin, A. J.

420,838. Apparatus for the remote control of railway points, signals, and the like. Tomlinson, A. V.

420,641. Suspension for bogies with coupled axles. Michelin et Cie.

420,740. Electromagnetic means for transmitting and receiving signals between a point on a railway line and a train travelling thereon. Citterio, S., and Vacchina, P.

Forthcoming Events

Apr. 23–27.—Model Railway Club, at Central Hall, London, S.W.1. Model Railway Exhibition.

Apr. 25 (*Thurs.*).—S.R. (London) Lecture and Debating Society, at Brunswick House, Vauxhall, S.W.8. "American Railway Operation," by Mr. C. E. R. Sherrington.

Apr. 26 (*Fri.*).—Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, 6 p.m. "Recent Developments in Hydraulic Couplings," by Mr. H. Sinclair.

Apr. 29 (*Mon.*).—Society of Engineers, at Geological Society, Burlington House, Piccadilly, London, W.1, 6 p.m. "Modern Methods of Engineering Training," by Dr. Herbert Schofield.

Apr. 30 (*Tues.*).—Institution of Civil Engineers, Great George Street, London, S.W.1, 6 p.m. Ordinary Meeting.

Railway Students' Association, at London School of Economics, Houghton Street, W.C.2, 6 p.m. Annual General Meeting.

May 1 (*Wed.*).—Permanent Way Institution (Leeds), at Quebec House, Quebec Street, 7.30 p.m. "Some Recent Interesting Bridgework on the Southern Area, L.N.E.R.," by Mr. H. T. Bird.

May 2 (*Thurs.*).—Institution of Electrical Engineers, Savoy Place, London, W.C.2, 6 p.m. Kelvin Lecture. "The Molecular Structure of Dietetics," by Sir William H. Bragg.

May 3 (*Fri.*).—L.M.S.R. (London) Orchestral Society, in Shareholders' Meeting Room, Euston Station, N.1, 7.30 p.m. Concert.

Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, 6 p.m. "Progress in Design and Application of the Lysholm-Smith Torque Converter, with Special Reference to the Development in England," by Messrs. H. F. Haworth and A. Lysholm; "Voith Turbo Transmissions," by Dr.-Ing. W. Hahn.

Railway Club, at Royal Scottish Corporation Hall, Fetter Lane, London, E.C.4, 7.30 p.m. "Railways in the Air," by Mr. J. W. C. Logan.

May 6 (*Mon.*).—Industrial Transport Association, at British Iron and Steel Federation, Caxton House (East), Tothill Street, London, S.W.1, 6.30 p.m. "London's Traffic Problems," by Major H. A. Crawfurd, A.F.C.

May 7 (*Tues.*).—Institution of Civil Engineers, Great George Street, London, S.W.1, 6 p.m. James Forrest Lecture.

Diesel Railway Traction

Railway Oil Engines

AS time goes on the number of oil engine designs which are modified to suit traction requirements is increasing. There was a period in the development of diesel traction when certain makers appeared to think that if they had an oil engine weighing 50 lb. per b.h.p. or less, and standing within the confines of 13 ft. 6 in. high by 9 ft. 0 in. wide it was *ipso facto* suitable for locomotive work. In the majority of instances railway officers did not bite, and in consequence the makers who really had devoted money and time to the problem reaped the benefit. There is now a more general appreciation of the particular problems of railway operation which affect the oil engine, as may be seen by examining the designs of some of the British-built engines described in this issue. These engines are intended more particularly for locomotive work, where a light-weight high-speed unit is neither necessary or desirable, and they strike the happy medium between a very highly-rated machine and one in which the available space and weight is not used to best advantage. That satisfactory designs incorporating all types of cylinder heads, sleeve valves, and poppet valves have been evolved indicates that no one feature of the diesel engine is essential to its success, and that refinements having for their purpose the advancement of the thermal efficiency by one or two per cent. are, or should be, considered as subservient to the production of a workmanlike machine which will run with the minimum of attention. The importance of fuel consumption is not due to the possibility of running up a big bill (the fuel cost averages only 10 to 12 per cent. of the net operating cost of a diesel vehicle), but to the fact that, in general, an engine with a low unit consumption is cleaner internally and externally, which is a telling factor in any claim made for good workmanship.

80 m.p.h. Diesel Schedules

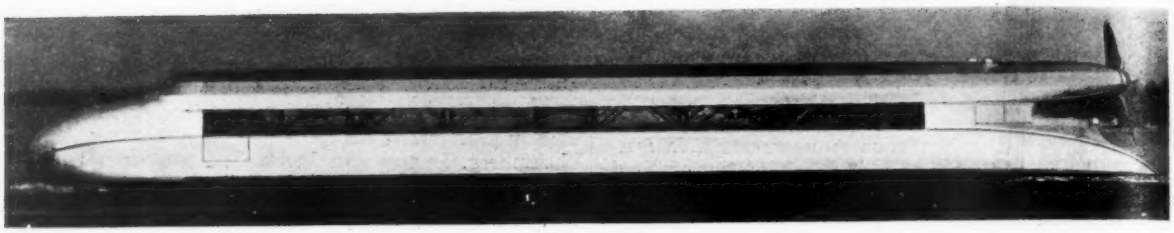
AS shown by the summer timetables of the Reichsbahn, great speed developments are to come into force on May 15 over certain main lines in Germany, and the most noteworthy of these new schedules are to be operated by diesel trains. The 360 miles from Cologne to Berlin are to be covered at an average of 67·5 m.p.h., including seven intermediate stops, and an intermediate start-to-stop timing of 84 min. over the 109·7 miles from Hamm to Hanover, giving an average of 78·4 m.p.h. On the return trip the overall speed inclusive of six stops is to be 70·5 m.p.h., but the 157·7 miles from Berlin (Zoo) to Hanover are to be reeled off in only 115 min., equivalent to 82·3 m.p.h. Another eighty is included in the schedule of the diesel train which is to run between Frankfort and Berlin at an average of 65·8 m.p.h. for the 335 miles; the 102·3 miles between Leipzig and Berlin (Anhalter) are to be covered in 76 min. at a start-to-stop speed of 80·9 m.p.h., and in the reverse direction in 77 min. at 79·6 m.p.h. We understand that these schedules will not operate from May 15, as shown in the timetables, because the trains which are to work them will not be ready owing to various modifications and adjustments which have been found necessary. These units will be introduced later in the summer, along with others which are to operate on a 61·4 m.p.h. timing over the 419 miles between Munich, Nuremberg, Leipzig and Berlin, and a 65 m.p.h. service (including seven stops) over the 280 miles between Cologne, Bremen, and Hamburg. The new trains will comprise both 820 and 1,200 b.h.p. units of two and three cars respectively; they will have second-class accommodation only and a buffet service will be provided. The Flying Hamburger will continue on its normal schedule of 77·4 m.p.h. down and 76·3 m.p.h. up between Berlin and Hamburg.

Super Speed and Safety

IT has been left to diesel vehicles to demonstrate that start-to-stop schedules of 80 m.p.h. can be realised in everyday working, and, indeed, it is hardly too much to say that they provide the only form of traction on rails which could maintain such speeds with regularity. It is due to the diesel, too, that so much advance has been made recently in the speed of steam-worked trains. But there is a limit to which the steam engine can go, not so much in the realm of sheer speed on the straight level but in the speed which can be maintained round curves, and in the rates of acceleration and deceleration from and to speed restrictions. With speeds in the neighbourhood of 100 m.p.h. or more the danger of overturning on curves normally considered easy is not negligible with modern steam locomotives having centres of gravity of 5½ ft. or more, and calculations on the Continent have shown that at a speed of 100 m.p.h. as much as three quarters of the weight might fall on the outer wheels. On a long run with an appreciable proportion of curved track the high centre of gravity might lead to schedules distinctly slower than would be possible with streamlined diesel trains, in which the centre of gravity rarely exceeds 4·6 ft. in this country and on the Continent. With speeds regularly in excess of 110-115 m.p.h. it seems as if even the high-speed diesel train may require some modification to its running gear if the line is at all curved. Kruckenberg found a solution by adopting steered axles, thus following a practice introduced to railways a century ago in the horse-drawn car on the Budweis-Linz line in Austria. In this manner flange wear was almost eliminated, and hand in hand with flange wear goes rail wear, the problem of which has, however, been virtually solved within the last few years by lubrication. The super-speed train must run in safety over tracks used at much lower speeds by heavy steam locomotives. It is this latter traffic which makes the problem of running round curves at speed most acute, for if the line were superelevated for the highest speed, an undue proportion of the weight of vehicles running at low velocities would fall on the inside rail, with various undesirable results. There is a further field for research in the fit between the flange and the rail. Useful work has been done in France and Denmark on the coning of wheel treads, and high-speed vehicles with treads having a 1 in 40 taper are now running with notable steadiness in both countries.

FAST RUNNING WITHOUT DERAILMENT

By Dr.-Ing. BÄSELER, of the Reichsbahn



The Kruckenberg railcar as it was when it attained the record speed of 143 m.p.h.

PRESENT-DAY conditions, coupled with the constant rivalry of road traction, make it imperative to face the question of increasing the speed of railway travel. Whilst no finality is claimed for the ensuing remarks, they may help to crystallise the fundamental problems involved. It seems probable that in Germany, at least, high-speed rail vehicles of the future will fall into two groups: (1) express railcars, with streamlining a primary, and weight a secondary, consideration, and (2) fast railcars, intended for working fairly heavily graded lines, and therefore as light as possible and capable of very quick speed recovery. The express car would have to be able to run its engines at full capacity for hours on end. This comes easily to a good steam or electric locomotive but, generally speaking, a diesel engine is not so well suited to the task.

The Flying Hamburger is composed of two long cars and has an engine power of 820 b.h.p. (although 1,200 b.h.p. is to be used for future cars). For a corridor train comprising ten cars and having an equal service capacity, five times as much horsepower would be needed, say 4,000 to 6,000. True, the end resistance falls, but the side resistance remains the same unless wind sheathing is employed, which is not easy to fit should the train not always form a set. There seems little sense in providing so much power, but having it all grouped in one unit is useful, as its working can be much better supervised. Fewer defects and failures are thus experienced, but in any case the failure of a part in a multiple-unit system is less grave than that of a steam locomotive.

The question of speed on curves is a vital one in this problem of attaining higher travelling rates. When one considers that 20 per cent. of the main lines of the Reichsbahn are on curves, and that in central and south Germany the percentage is considerably higher, it is apparent that no great increase in speed is to be hoped for until some radical change in German practice is made. On such sections a fast car has the advantage over an express car, on account of its great accelerative powers. The fact that the automobile has not yet been equalled in this respect is all the more reason why an attempt should be made, and the use of a fixed track offers a chance to do so.

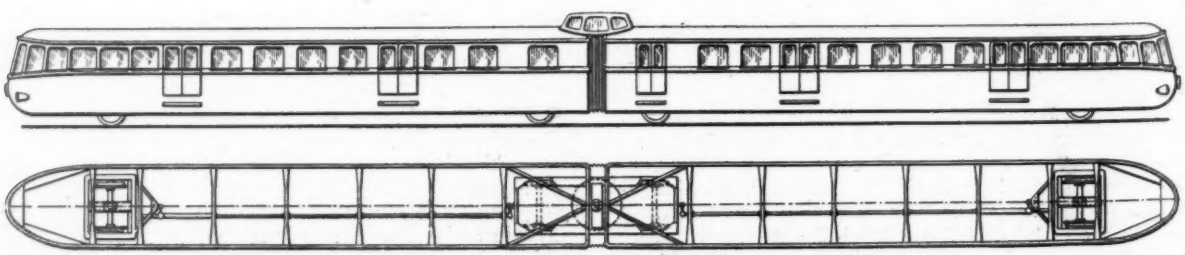
The Question of Curves

Curve, speed and superelevation stand in a fixed relation, depending on the law of centrifugal force, viz., $\left(g\frac{V^2}{R}\right)$ or, otherwise expressed, V (km.p.h.) = $K\sqrt{R}$ The constant K lies between 3 and 4 but nearer 4, according to contemporary railway practice. Taking the higher limit as a basis, it may be said that it is now usual to go to $V = 4\sqrt{R}$, thus:—

R m.	*V* km.p.h.	*R* m.	*V* km.p.h.
900	120	500	90
750	110	400	80
625	100	300	70

Through the fixed relationship $\frac{V^2}{R} = 16$, or $\frac{V^2}{R} = \frac{16}{3{\cdot}6} \times 2 = 1{\cdot}23$, the value of the centripetal acceleration p is equally highly fixed for all curves at 1·23 m./per sec. per sec. Taken in conjunction with the mass of the vehicle or passengers, it gives the force with which the vehicle has deviated from the direct path. The German terms " track pressure " and " track acceleration " may be used, but it must be remembered that the latter, although similar in nature to starting acceleration, operates transversely to the direction of travel.

Superelevation is used to counteract centrifugal force. Its height is limited by practical considerations. In Germany, for instance, it is 110 and 120 mm.; in Austria



Waggonfabrik Uerdingen design for a high-speed four-axled articulated unit

140 mm.; while on the severe curves of Switzerland 150 mm. is found. Now a track acceleration of 1·23 m. per sec. per sec. is $\frac{1{\cdot}23}{9{\cdot}81}$ = one-eighth of the acceleration due to gravity. The superelevation must therefore be 0·125 of 1,500 mm. (track width) = 187·5 mm. Actually it is less, so that part of the centrifugal acceleration (p_u) is not counteracted.

Superelevation	p_u
120 mm.	0·44 m.p.sec.p.sec.
140 „	0·31 „
150 „	0·25 „

In some cases it is higher, but not under German conditions.

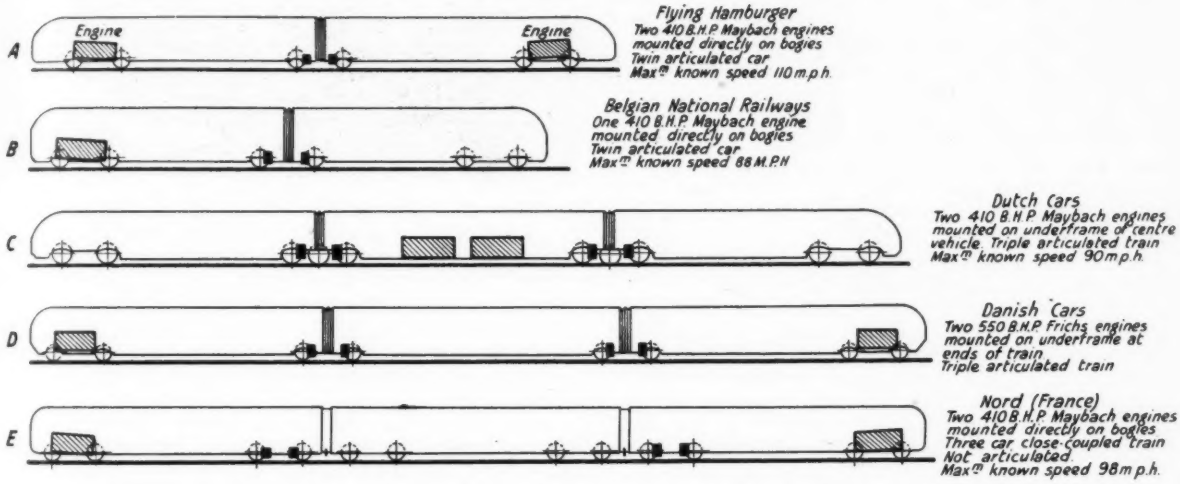
To increase speed on curves the first thought is to increase superelevation, which cannot as a rule be done, for slow trains also run on these curves. More difficulties arise on S bends, and engineers would like to flatten the line instead. Taking the highest value of 150 mm., or an inclination of 1 in 10, a tenth part of the centrifugal acceleration is counterbalanced. Suppose it is wished to raise the speed 50 per cent., which may also be expressed as from $V = 4\sqrt{R}$ to $V = 6\sqrt{R}$. The track acceleration rises when $V = 6\sqrt{R}$ to $p = 2{\cdot}8$ m. per sec. per sec. Of this, $p_u = 2{\cdot}8 - 1{\cdot}0 = 1{\cdot}8$ m. per sec. per sec. is not compensated and must be resisted by the vehicle and its passengers. Well designed cars conform to this rule with ease.

From the point of view of safety, the possibility of toppling over, or the dangerous removal of load from the inner wheels must be considered. The latter danger is very real in the case of steam locomotives having high boilers, and calculations show that such units would be inadmissible for the speeds contemplated, for the outer wheels would carry three-quarters, and the inner wheels only one quarter of the weight, which is not safe. As the gauge cannot be widened, future vehicles must have a low centre of gravity.

Security against derailment must also be considered. The Reichsbahn holds the opinion that the leading wheel is a danger point, a view that is countered by the remark that, were this so, there would be many more derailments. But trials and experiments show that the heavy pressure is there, and a bogie of 3·6 m. wheelbase feels it on curves of 800 m. radius. It is difficult to measure the exact forces at work, but a wheel that is running with a low margin of safety will derail should some untoward incident occur. There are some classes of locomotives with a reputation for derailing in a given set of circumstances. The danger occurs when flange pressure equals wheel pressure, but as a rule the safety factor is $n = 2$.

Taking the track acceleration previously mentioned, it is found that the flange pressure becomes 0·86 of the wheel pressure, and the safety factor drops to 1·16 when uncompensated. This is overlooking the fact that cars with a low centre of gravity, such as are proposed, will be helped by having the centrifugal force loading the outer wheel. As the centre of gravity cannot be lower than 1·0 m. above rail level, 12 per cent. more load will be given on the outer wheels. The safety factor will be 1·3, which is not enough. It must also be remembered that in fast running, all dynamic forces show a marked increase, coupled with a greatly reduced time to recover from any small irregularity.

There is the permanent way itself to be considered also. Express traffic makes heavy demands on the track, and irregularities become intolerable at very high speeds. Fortunately all aspects of track maintenance have been greatly improved, including methods of detecting flaws. The damaging powers of some types of vehicle need to be studied and lateral stiffness of the permanent way must be ensured. It has been suggested that high-speed trains could be rendered safer by the use of check rails each side, such as the Marienfelde-Zossen line had before the war, when 210 km.p.h. (130 m.p.h.) was attained. It is, however, debatable whether this plan gives greater safety. Should a bad derailment occur in these new express services—no matter for what cause—the whole question would become one of utmost urgency.



Five types of streamlined trains on the Continent

The Question of Steering

The danger, then, is in the action of the leading wheels when taking curves. Why, one might ask, does a motor car, which has a very great centrifugal effect, work with greater safety? The answer is that car wheels are steered. If possible, the wheels of rail vehicles must be steerable, so that the leading flange need no longer do all the work and overcome the friction of the loaded wheels as it turns. The task of steering or directing the wheels has been given much consideration, and was actually adopted in the Kruckenberg car, as originally built, and high-speed travel demands it. A steering wheel is unnecessary because a long railway

vehicle has at least three axles, and their relative positions on the curve can be made to give some steering action.

When p_a = 1·8 m. per sec. per sec. and the axle is set radially, its own 25 per cent. frictional grip will take up the 18 per cent. side pressure without allowing the flange to gain the outer rail. The wheel now need only take up the uncompensated centrifugal effect, and the factor of safety rises to 2·8, or even to 3·0.

Evidently a car which could take curves fast and safely would alter high-speed services radically. It would also cut down costs, as less braking and subsequent acceleration would be necessary. One plan for such a vehicle would be a double car, seating from 100 to 130 persons. The axle number could be reduced from eight to six if an articulation bogie was fitted in the middle. Three axles, however, would suffice to carry the weight, or four, counting the middle bogie, and from 10 to 15 per cent. greater acceleration should be obtainable than at present owing to net weight reduction. Waggonfabrik Uerdingen has designed such a double car, having linked-up bogies and radial axles. Needless to say, strong, perfectly sprung construction is essential. Welded track completes this picture of perfection, but is still in the clouds of unreality.

Opposition to the proposal of steering axles is found in the objection that the effect comes too late. This is not so, particularly in the case of transition curves, and it is only at the beginning and end that some loss of benefit occurs, and even then a good factor of safety remains. There must always remain some points where speed must be reduced, but this can be assured by the use of good automatic train control system.

Such a car as has been suggested would need to be made low, giving easy ingress for passengers, and the driver would be given a central cab. The curves must also be taken without causing discomfort to the passengers. Uncomfortable travelling is caused by slackness between wheel and rail, and a better fit in this respect should be considered. It may be that a new design of seat will have to be evolved, comprising side sprung arm and head rests and other modifications giving extra comfort. Forewarned is forearmed, and a warning buzzer of dulcet tones might be employed to enable passengers to prepare themselves, mentally and physically, for a rapid deviation from the straight.

End view of the streamlined articulated 500 b.h.p. Renault diesel train on the French State Railways

Publications Received

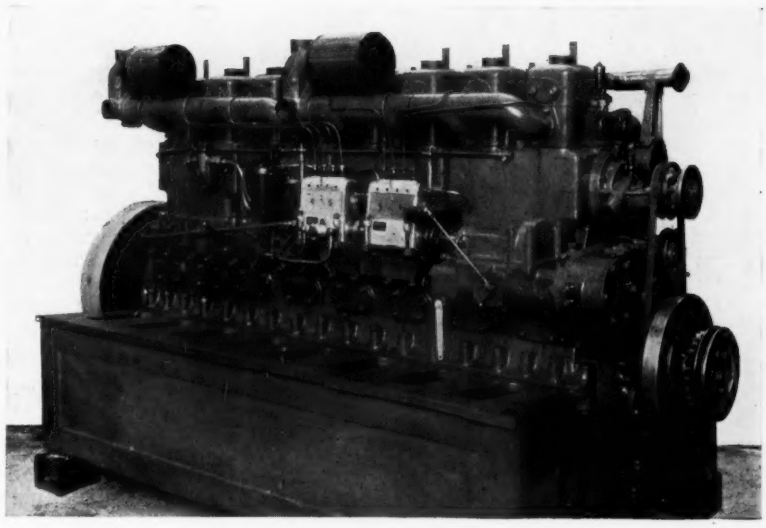
Modern Heavy-Oil Engines Simply Explained. By R. Barnard Way. London: Percival Marshall & Co. Ltd., 13-16, Fisher Street, W.C.1. 7½ in. × 5 in. 267 pp. Illustrated. Price 5s. net.—The story of the design, construction and working of the heavy-oil engine, and its application as a power unit to stationary plants and to all forms of transport, is admirably set forth within the 264 pages of this book. The style of writing is admittedly non-technical; but this should ensure that the book will be read by a far larger number of readers than might otherwise have been the case. Over one hundred remarkably clear drawings, specially prepared by the author, add a very great deal to the utility of the volume, while many excellent photographic illustrations of oil-engined power units of all kinds enhance the interest of the story. The oil-engined power unit, as applied to railway locomotive purposes, is dealt with in two chapters, one describing the mechanical, and the other the electrical transmission of the power developed by the engine. The period covered is from the Klose-Diesel-Sulzer locomotive of 1909 to the Maybach engine of today. All the more important locomotives of the two types mentioned, which have been designed and constructed in the interim, are noted and described; and, in a few cases, the results of actual trials are also given. But far too much space is devoted to experimental types like the Kitson-Still, Ansaldo, and M.A.N. compressed air locomotives, and not sufficient attention given to the large variety of really successful vehicles. Although the author appears to be an enthusiast in his subject, he is to be congratulated upon the fact that he never allows his enthusiasm to obliterate actual facts; he tells his story simply, concisely and accurately, and with a remarkable absence of rhetoric. The book is well printed on excellent paper and should be useful alike to the expert and the tyro.

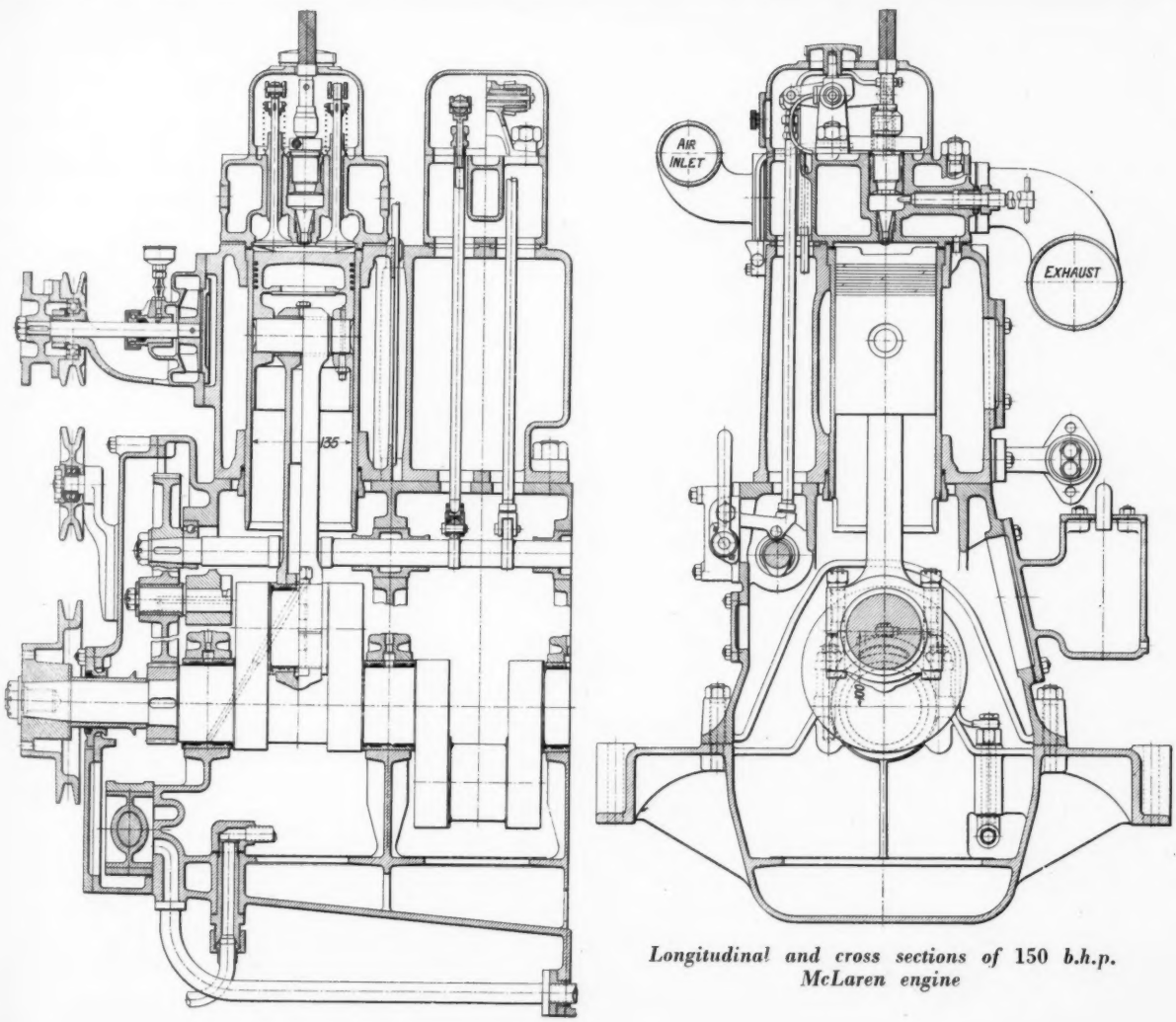
Lubricating Oil Tests and Their Significance. By J. E. Southcombe, M.Sc. Third Revised Edition. London: Germ Lubricants Limited, 735-741, Salisbury House, E.C.2. 8½ in. × 5½ in. × ¼ in. 85 pp. Illustrated. Price 2s. 6d. net.—This book forms a welcome contribution to a subject, the technicalities of which tend to obscure the bird's-eye view of the problem which is generally desired. The more significant factors are set out in a clear and concise manner, and enable the ordinary engineer to grasp the essentials of lubrication without himself becoming badly overheated in the process. The various tests by which the principal characteristics of different oils are determined are described with commendable simplicity, together with notes on the relation of these characteristics to lubrication practice. We think that the advocacy of Germ products might have been achieved more subtly and more effectively by a less frequent reference to their names in the text, and the incorporation of a suitable appendix containing matter and illustrations of the relative behaviour of these products, without the risk of that over-emphasis which so often tends to defeat its own purpose.

McLAREN 150 B.H.P. LOCOMOTIVE DIESEL ENGINE

AMONG the oil engines which are being applied to railway traction in increasing numbers is the range of pre-combustion chamber designs built by J. & H. McLaren Limited, of Leeds. The largest railway model at present being turned out by this firm has a continuous rated output of 150 b.h.p., and it is this engine which is installed in one of the diesel shunting locomotives built by the Hunslet Engine Co. Ltd. for the L.M.S.R., and described in the issues of this Supplement for December 29, 1933, and April 20, 1934.

The engine is made up of eight cylinders having a bore of 135 mm. (5·31 in.) and a stroke of 200 mm. (7·87 in.). When developing 150 b.h.p. at 1,000 r.p.m. the piston speed is 1,315 ft. per min. and the brake m.e.p. 85 lb. per sq. in. The cylinders are cast in pairs, and have hardened cast-iron liners which are held





Longitudinal and cross sections of 150 *b.h.p. McLaren engine*

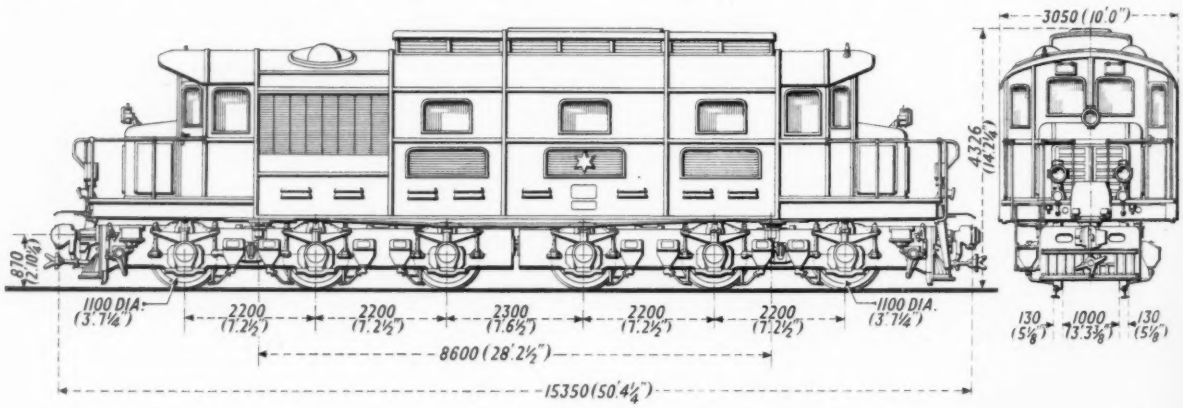
in position by the cylinder head. The joint at the cylinder head is made with copper washers, and at the bottom end the liner is sealed by means of a rubber ring located by a gland. The pistons are of cast iron and are fitted with fully-floating gudgeon pins. Hollow-bored circular connecting rods are fitted, and have bronze bushes at the small end. At the big end the white-metal lining is supported by a gun-metal bush, but the main crankshaft bearings have white-metal linings on phosphor-bronze shells. The six-throw crankshaft is in one piece, with circular webs, and is neither hollow-bored nor fitted with balance weights.

As may be seen from the accompanying drawings, the camshaft lies in the upper portion of the crankcase (the crankcase is cast separately) and drives the overhead rockers through vertical push rods. A de-compression lever is fitted for use when starting the engine. A double-unit C.A.V.-Bosch pump delivers the fuel to the C.A.V.-Bosch injection nozzles in the Benz pre-combustion chamber; the two pump units are connected together by a steel coupling. The speed is controlled through a lever attached to the spring of the centrifugal governor. Special precautions have been taken in the filtering of the fuel oil. After passing through strainers in the tank, the fuel goes through an Auto-Klean strainer and a fabric strainer before it reaches the cylinders. All of the engine constituents are pressure-lubricated, and the lubricating oil circuit includes both Auto-Klean and suction strainers. The lubricant is circulated between the sump and the cooler by a pump which prevents pressure in the oil-cooling elements of the radiator, and which is additional to the lubricating oil pump.

As applied to the L.M.S.R. shunting locomotive, a standard sump was not fitted, but the sump and baseplate were combined into a strong casting which formed also a locomotive frame stay and assisted in the perfect alignment of the crankshaft. The starting of this McLaren engine can be accomplished by any of the usual methods.

BIG SUPERCHARGED LOCOMOTIVES FOR EQUATORIAL AFRICA

THE new French-owned metre-gauge Congo-Ocean Railway, running from Pointe Noire on the Atlantic to Brazzaville on the banks of the Congo, and described in THE RAILWAY GAZETTE for July 13, 1934, has ordered from Les Forges & Aciéries de la Marine et d'Homécourt three double-bogie diesel-electric locomotives of the Co + Co type for the operation of passenger and goods trains over the whole 318 miles of route. When hauling a 250-ton passenger train the end-to-end speed will be 31 m.p.h., including four stops of five minutes' duration each and the negotiation of 1 in 45 grades and curves of 328 ft. radius. The goods trains will weigh from 300 to 480 tons, but on certain sections over which it is desired to operate 700-ton trains, two of these 84-ton locomotives will be coupled in multiple-unit and operated by one man.

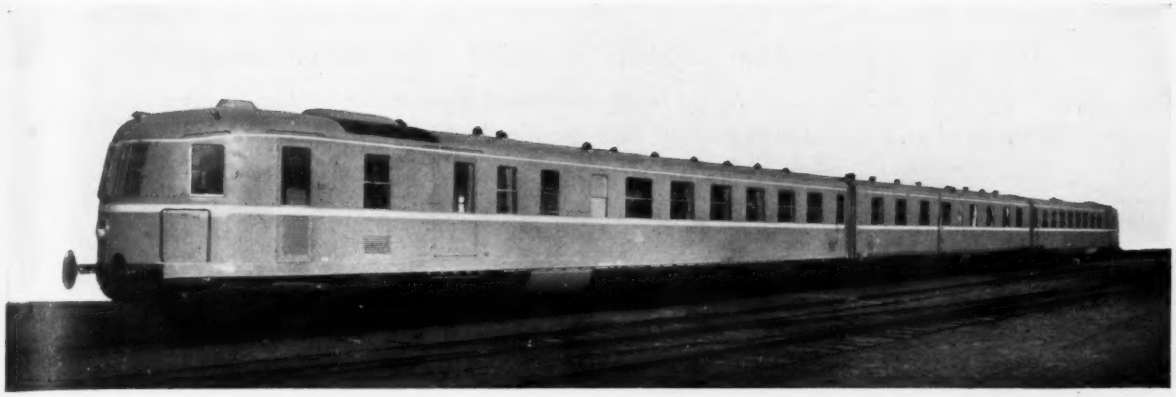


920 b.h.p. diesel-electric locomotive for the Congo-Ocean Railway

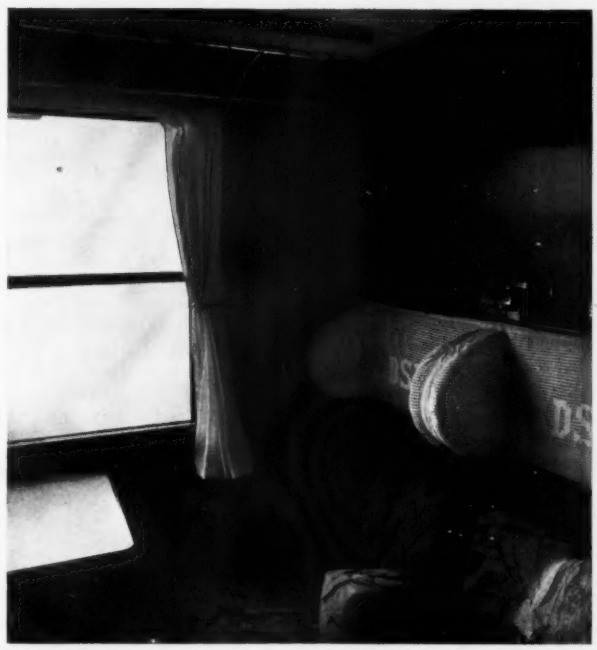
A six-cylinder M.A.N. engine is incorporated, and is supercharged by a turbo-blower on the Rateau system. The continuous rating is 830 b.h.p. at 700 r.p.m. and the hourly figure 950 b.h.p. at the same speed, the supercharger being in action in both cases. Without pressure-charging the normal output is 655 b.h.p. at 700 r.p.m. The Rateau blower is driven by the exhaust gases from the diesel engine, and the speed and pressure of the blower are thus in proportion to the engine output. Supercharging was incorporated partly because of the variable nature of the duties to be performed, and partly to compensate for the unfavourable conditions of altitude, humidity, and temperature under which the locomotives will work in French Equatorial Africa. The engine circulating water is cooled in side radiators through which air is drawn by an electrically-driven fan mounted in the roof.

The engine is directly-coupled to a d.c. generator, and the auxiliary generator is mounted on an extension of the main armature shaft. This auxiliary generator does not function as an exciter, the excitation of the main generator field being effected by a special machine driven from one of the axles, in accordance with the principles of the Jeumont system of control with which the locomotive is fitted. In this method, each controller notch corresponds to a definite engine output and is virtually independent of the locomotive speed. To provide excitation at starting, before the locomotive is moving, a cadmium-nickel battery is incorporated to supply current to the main generator fields. Six nose-suspended traction motors are used to drive the wheels.

A single cab and underframe structure extends over the two bogies, and houses the power unit in a central compartment. There is a driving compartment at each end. The automatic centre couplers and cowcatchers are mounted on the headstocks of the bogie frames, and all buffing and drag stresses are transmitted through the bogies and kept away from the cab. Compressed air brakes of the Westinghouse type are fitted.



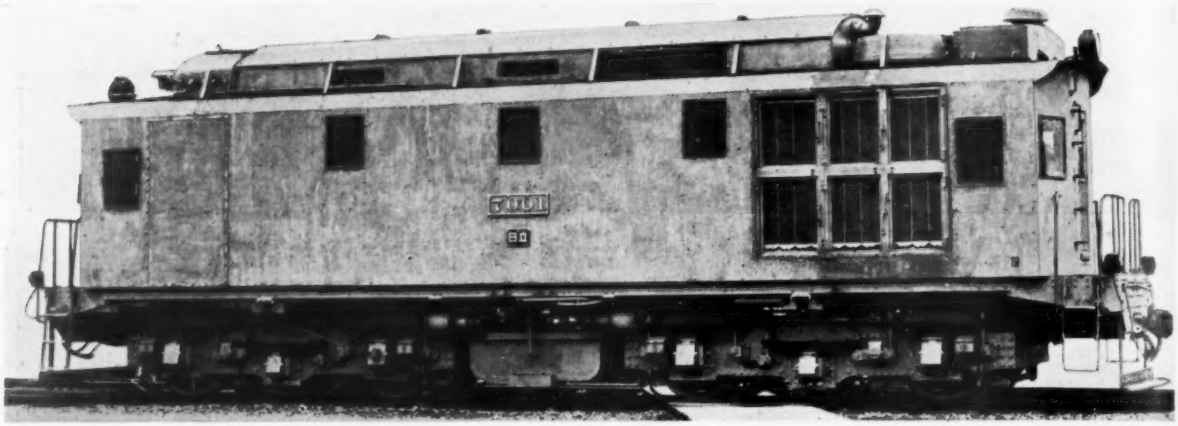
The four Frichs 1,100 *b.h.p. diesel-electric trains for the Danish State Railways are now running experimentally, prior to being put into regular service on May* 15. *They will provide fast services on the Copenhagen-Aalborg and Copenhagen-Esbjerg routes. The time between London and Copenhagen via Esbjerg will be cut by* 4 *hr.* 40 *min. by the use of the diesel trains and the opening of the Little Belt bridge. First and third (or common) class accommodation and a buffet are provided, and the trains are painted bright red with a cream line below the windows. The power plant at each end of the train consists of a double* 275 *b.h.p. Frichs engine and a d.c. generator. A detailed description of the design was given in the issue of this Supplement for August* 10, 1934



THE NEW DIESEL LYNTOG (OR LIGHTNING TRAINS) IN DENMARK

DIESEL TRACTION DEVELOPMENT IN MANCHUKUO

After experience with heavy locomotives and light railcars, the South Manchuria Railway is putting into service six semi-streamlined trains



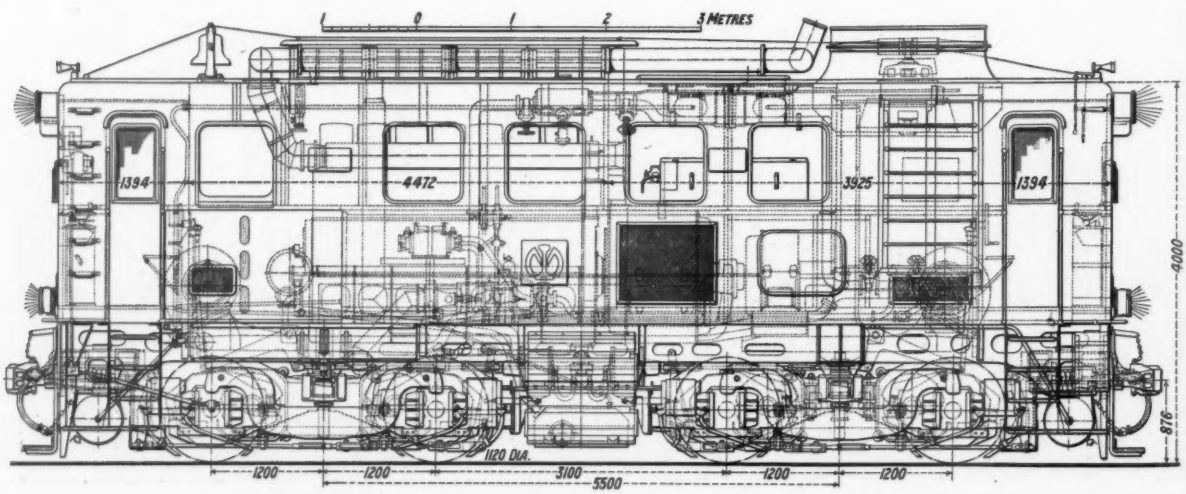
One of the two Japanese-built 750 b.h.p. diesel-electric shunting locomotives on the South Manchuria Railway

DIESEL traction was introduced into Manchuria in 1931, when two heavy locomotives with electric transmission were set to work in shunting service and on local goods trains. Notes on tests carried out with these units (one of which was powered by a 700 b.h.p. M.A.N. engine and one by a 750 b.h.p. Sulzer engine), were published in THE RAILWAY GAZETTE for February 26, 1932. Further references to these two vehicles will be found in the *Diesel Railway Traction Supplement* for February 24 and June 16, 1933. These locomotives were followed in the next year by two 250 b.h.p. diesel-electric railcars with Sulzer engines and bodies built at the Shakako works of the South Manchuria Railway.

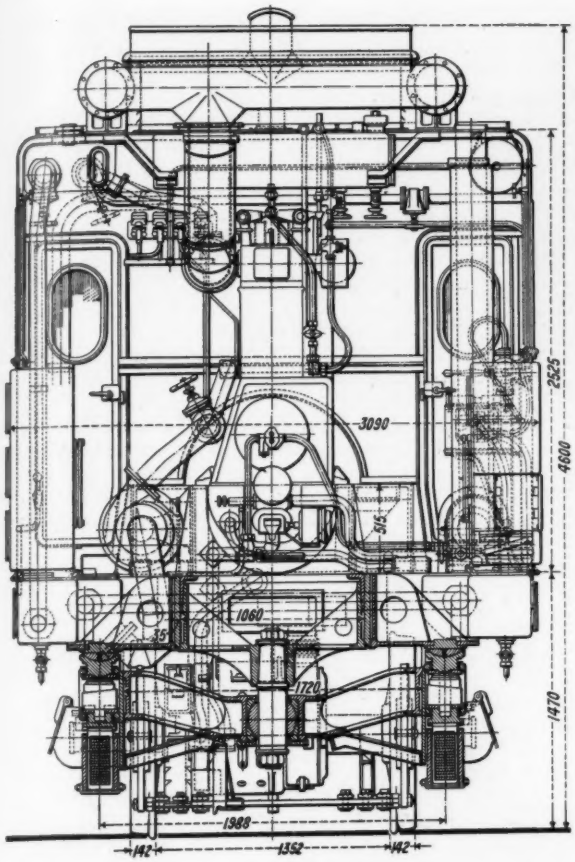
Subsequent development has incorporated both European and Japanese products. In 1933 two very heavy double-bogie shunting locomotives with the AIA-AIA wheel arrangement were acquired from Japan, and one of them is shown in the illustration at the head of this article. Last year a light double-bogie railcar was built in the Shakako workshops of the S.M.R. and fitted with a 120/130 b.h.p. A.E.C. engine sent out from England, and at the present time six four-car diesel-electric train sets are under construction at Shakako; four of them are to be fitted with Sulzer engines and two with a Japanese make. A possible future development is the construction of streamlined trains for a super-speed service between Dairen and Hsinking. In the compilation of the following notes on the S.M.R. diesel stock we have had the assistance of Mr. S. Nonaka, the Chief Mechanical Engineer, under whose direction the various diesel vehicles have been built.

Diesel Locomotives

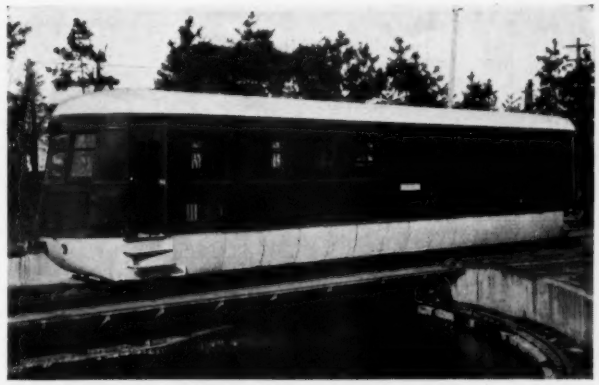
The two diesel locomotives of 1931 were purchased in order to give a trial to diesel traction with the products of different firms, and the operating characteristics of both units are almost the same. Locomotive No. 2000, as



General arrangement of Esslingen-M.A.N. 700 b.h.p. diesel locomotive, S.M.R.



Above: End view of 700 b.h.p. M.A.N.-engined locomotive

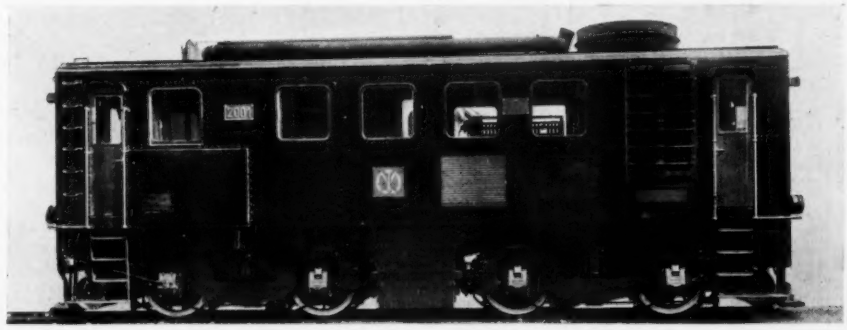


A.E.C.-engined 130 b.h.p. diesel railcar, South Manchuria Railway

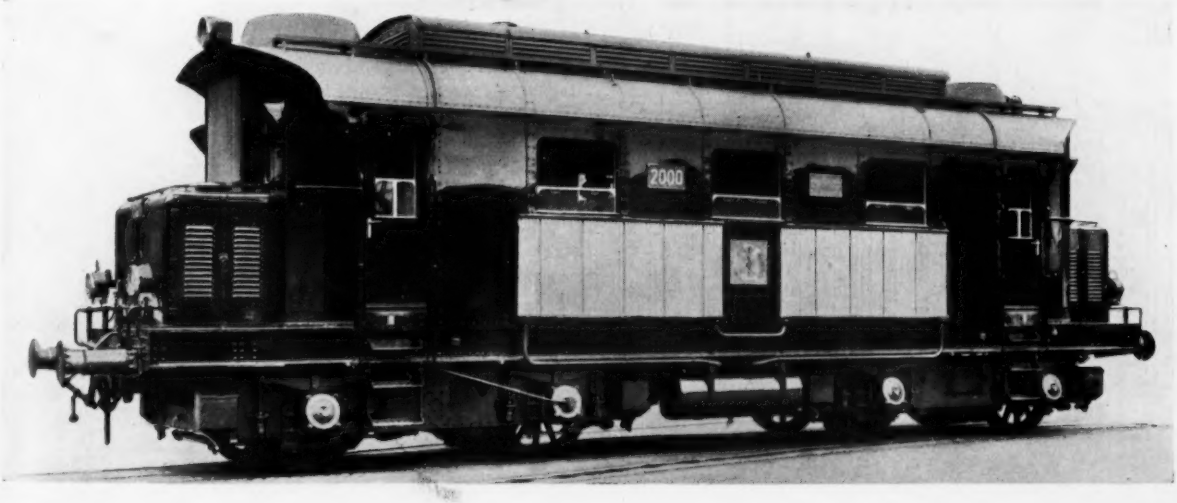
illustrated at the bottom of this page, was supplied by Sulzer as main contractor, and has one of that company's four-stroke engines developing 750 b.h.p. at 620 r.p.m. in eight cylinders with a bore of 310 mm. (12·2 in.) and a stroke of 370 mm. (14·5 in.). Cooling of the engine circulating water is carried out in two radiators mounted on the cab weatherboard, and air is drawn between the gilled tubes by a fan mounted in the roof. The lubricating oil is not cooled in certain elements in the water radiator tanks, but in entirely separate elements secured to the outside panels of the engine compartment.

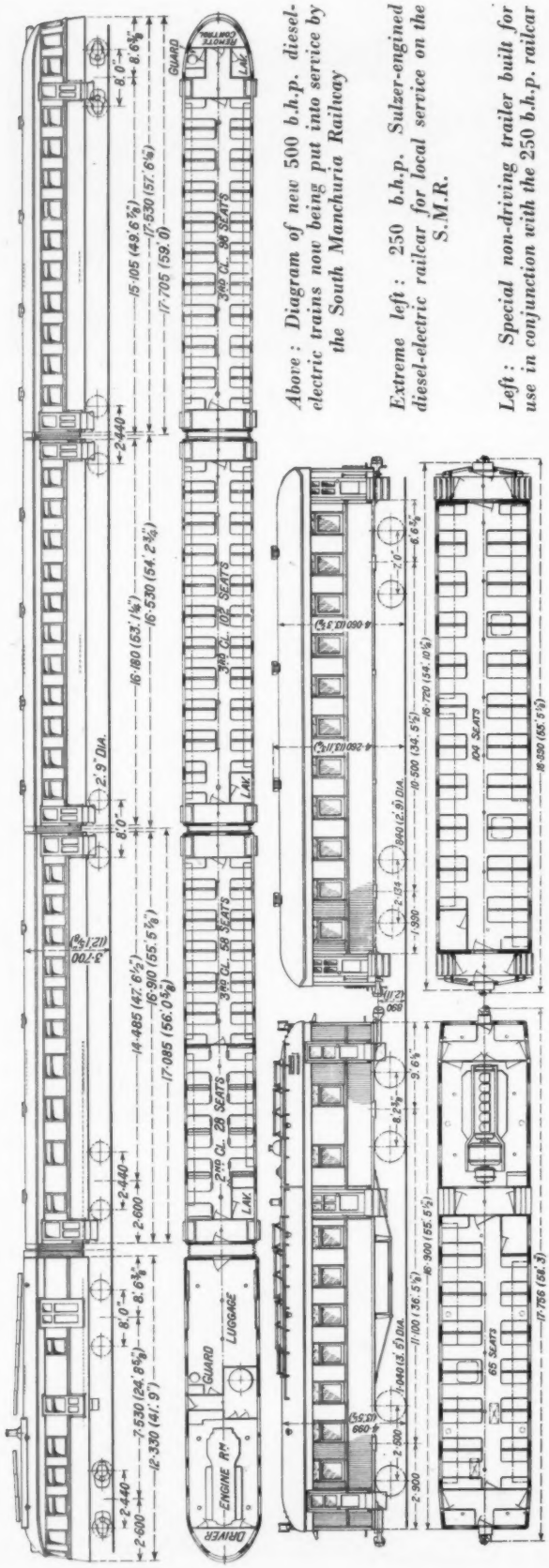
Oerlikon electrical equipment is installed, and consists of a 500 kW. (maximum) direct-coupled main generator and a 50 kW. 150-volt overhung auxiliary generator. The normal output of the main generator corresponds to 750 volts 700 amp., but a maximum starting current of

Right: General view of Esslingen-M.A.N. oil locomotive, South Manchuria Railway



Below: 750 b.h.p. diesel-electric locomotive built by Sulzer Bros.





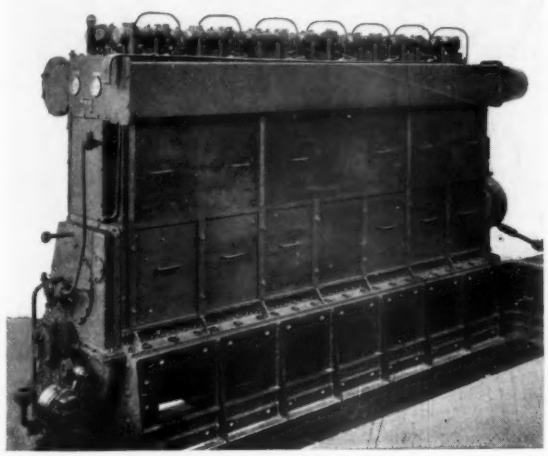
Above: Diagram of new 500 b.h.p. diesel-electric trains now being put into service by the South Manchuria Railway

Extreme left: 250 b.h.p. Sulzer-engined diesel-electric railcar for local service on the S.M.R.

Left: Special non-driving trailer built for use in conjunction with the 250 b.h.p. railcar

1,900 amp. can be delivered. The four 135 h.p. nose-suspended traction motors operate at a maximum voltage of 750, and drive the 1·12 m. (43-in.) wheels through 5·16 : 1 spur gearing. The engine is started electrically, current being supplied for this purpose to the main generator by a 130-volt 400 amp. hr. storage battery. The bogies have a wheelbase of 2·5 m. (8 ft. 2½ in.) and are pitched at 6·7 m. (21 ft. 11 in.) centres; the locomotive extends over a total length of 13·3 m. (43 ft. 8 in.) and weighs 81·6 tonnes (80·3 tons) in working order. The maximum tractive effort is 16·2 tonnes (35,750 lb.), and the top speed 60 km.p.h. (37·3 m.p.h.).

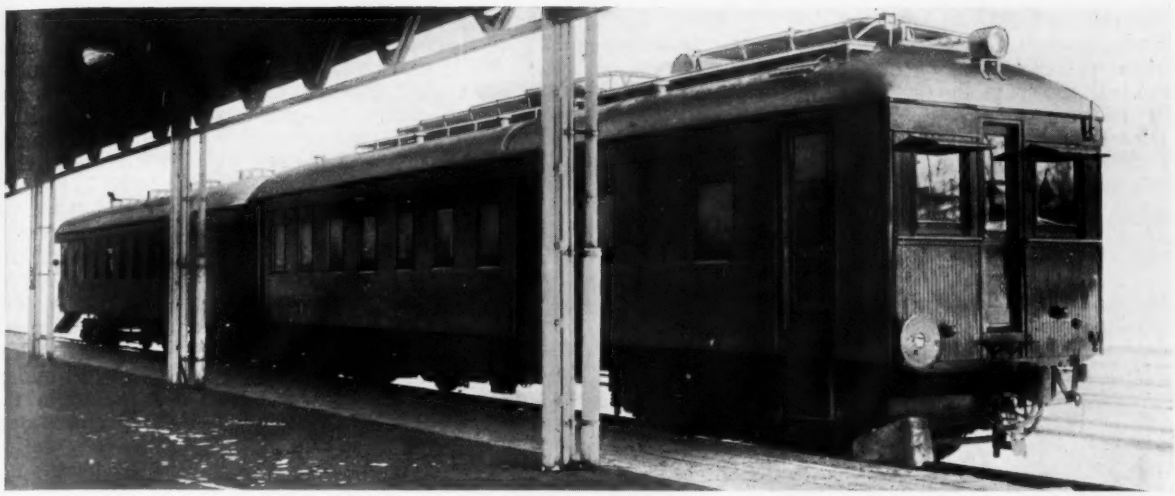
Although generally similar in operating characteristics, locomotive No. 2001 presents a different appearance and has totally different mechanical portion details. The engine is of M.A.N. manufacture and has a rated output of 700 b.h.p. at 700 r.p.m. in seven 280 mm. by 380 mm. (11 in. by 15 in.) cylinders. It incorporates direct injection in place of the pre-combustion chamber head of the Sulzer engine. The electrical equipment was built by Brown Boveri and embodies a modified Ward Leonard control. The main generator has a maximum capacity



700 b.h.p. M.A.N. diesel engine

of 450 kW. (435 kW. normal) at a maximum voltage of 750. The compound-wound 150-volt auxiliary generator is of the overhung type with a capacity of 68 kW., and the four traction motors are of 134 h.p. and transmit their torque to the wheels through gears with a ratio of 4·7 to 1. The main differences in the construction of the mechanical portion (which was built by the Maschinenfabrik Esslingen) compared with the Sulzer locomotive may be seen by comparing the drawings of the former with the illustration of the latter. The bogies of the Esslingen machine take the superimposed weight through spring-supported spherical side-bearers, the centrepin acting as a pivot only. The maximum tractive effort and speed are the same as those of locomotive No. 2000.

When further shunting locomotives were required in 1933, Japanese-built units (Nos. 7000 and 7001) were acquired and they embody certain features found in Nos. 2000 and 2001. Although the maximum tractive effort of the 1933 locomotives is the same (35,750 lb.) as that of the two earlier units, the weight is considerably greater, totalling 118 tonnes (116·5 tons) in working order. Two six-wheel bogies were necessary to distribute this weight without exceeding the permissible axle-load, and the two outer axles of each bogie are driven by 225 h.p. motors



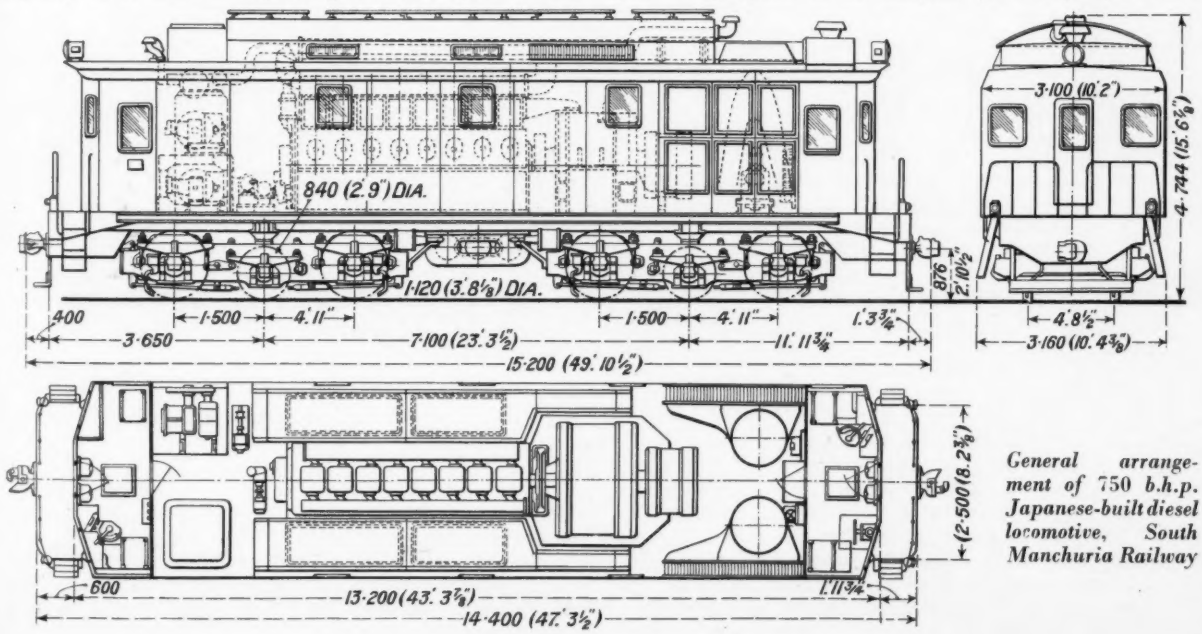
250 b.h.p. Sulzer-engined railcar, South Manchuria Railway

with a gear reduction of 4·39 to 1. The six-cylinder Niigata diesel engine develops 750 b.h.p. at 600 r.p.m. and in cylinder dimensions is a combination of the M.A.N. and Sulzer designs, the bore being 310 mm. (12·2 in.) and the stroke 380 mm. (15 in.). The engine circulating water is cooled in two radiators having separate electrically-driven fans. The main generator is of 450 kW. capacity, with a differential compound winding, and the electrical control is on the modified Lemp system. The storage battery used for engine starting and for the auxiliaries is of 112 volts 458 amp. hr. capacity.

Railcars and Trains

The first diesel cars of the South Manchuria Railway were set to work in 1932. They incorporate 250 b.h.p. Sulzer engines similar to the Armstrong-Sulzer engine used in the L.N.E.R. *Tyneside Venturer,* and Brown Boveri electrical equipment with control on the modified Ward Leonard system. These cars have a normal seating capacity of 65 third-class passengers, but a special trailer has been built for attachment to each car and has seating accommodation for 104 passengers.

An engine output of 250 b.h.p. is obtained at a rotational speed of 795 r.p.m. (20 r.p.m. above the speed of the engine in the *Tyneside Venturer*). The direct-coupled shunt-wound d.c. generator has a rating of 170 kW. and a maximum voltage of 750; a maximum current delivery of 850 amp. can be obtained. The overhung exciter delivers current to the main generator field and to the auxiliaries at a voltage of 150, and has a rating of 11 kW. The two nose-suspended traction motors have a maximum voltage of 750 and are rated at 96 h.p.; they drive the 1·04 m. (41-in.) wheels by single spur reduction gear with a ratio of 5·5 : 1. The peak tractive effort at the rail is 3,500 kg. (7,750 lb.) and on the one-hour rating, 2,000 kg. (4,400 lb.) at 25 km.p.h. (15·5 m.p.h.). As built, the cars had a maximum tractive effort of 4,000 kg. (8,800 lb.) and a top speed of 65 km.p.h. (40·4 m.p.h.), but the characteristics have been modified to give a top speed of 80 km.p.h. (49·7 m.p.h.) with a



General arrangement of 750 b.h.p. Japanese-built diesel locomotive, South Manchuria Railway

consequent reduction in the peak tractive effort. Each car weighs 49·23 tonnes (48·5 tons) in working order but without passengers, and a trailer tares 24·2 tonnes (23·9 tons). Diagrams of the cars and the trailers accompany this article.

Of much lighter design the third railcar of the South Manchuria Railway was built in 1934 and is powered by an A.E.C. engine. This is rated by the S.M.R. at 120 b.h.p. at 1,800 r.p.m. The vehicle is of the double-bogie type with the side panels carried down close to the ground level to give a semi-streamlined contour. Only one driving compartment is fitted and the seating accommodation is limited to third class. The maximum speed is 80 km.p.h. (49·7 m.p.h.) and the weight in working order but without passengers, 23·4 tonnes (23 tons). This car is now in service on short main line trips and on local branches in the vicinity of Dairen.

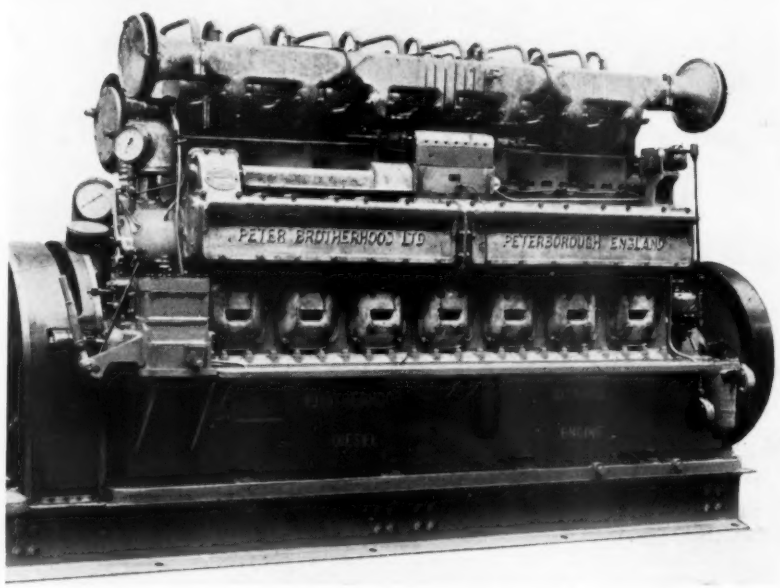
Of the six four-car trains now being built, two are expected to be in service within the next few weeks, but it will be the end of the summer before the sets which are to be powered by Sulzer engines go into service. As may be seen from one of the accompanying diagrams, the engine and luggage compartments are arranged in a short vehicle at one end of the train. A driving compartment is fitted at each end of the train, but normally the set will run with the engine end leading and use made of the triangles and loops at certain main-line stations to keep this end to the front. Only when working suburban trains on the Dairen to Port Arthur line will advantage be taken of the double-end drive. In view of their large seating capacity, 28 second class and 258 third class, these trains should be particularly suitable for suburban work, as well as for semi-fast work on the main line.

Both the Sulzer and Niigata engines will develop 500 b.h.p. at 500 r.p.m. in six cylinders 250 mm. by 310 mm. (9·87 in. by 12·2 in.). The differentially-wound separately-excited main generator is rated at 290 kW. and the compound-wound exciter is of 20 kW. capacity with a voltage of 130. The four traction motors are mounted on the end bogies and are rated at 150 h.p. each; they drive the 840 mm. (33-in.) wheels through 2·26:1 reduction gearing. The lighting, and the auxiliaries when the engine is not running, are worked from a 130-volt 280 amp. hr. battery, which also supplies the current for starting the engine. A modified form of Lemp control is fitted to these trains, which will have a top speed in excess of 60 m.p.h. The weight in working order but without passengers is approximately 110 tons, equivalent to 870 lb. per seat, and 4·55 b.h.p. per ton. Considerable economy in train operation is expected from the adoption of these trains, for the three diesel railcars now in service (two of them hauling a trailer) have an operating cost (exclusive of maintenance) of 14·91 yen per 100 train-km. (28s. 0d. per 100 train-miles) compared with 22·98 yen per 100 train-km. (43s. 3d. per 100 train-miles) of the previous steam trains, which were hauled by 0-8-0 reciprocating steam locomotives.

Taken over a period of 12 months, the cost of fuel, lubricating oil, grease, waste and sundries for the four diesel locomotives while operating in shunting and local goods service amounted to 11·98 yen per 100 km. (21s. 9d. per 100 miles at the present rate of 17 yen to the £). The operating costs, including wages and maintenance but excluding heavy overhauls, was about half the corresponding figure for steam engines. The cost of fuel was 49 yen (57s. 6d. at the present rate of exchange) per ton.

BROTHERHOOD 350 B.H.P. DIESEL ENGINE

THE smaller size of six-cylinder Brotherhood-Ricardo engine for rail traction service has been described already in this Supplement in connection with one of the L.M.S.R. 150 b.h.p. diesel-mechanical locomotives (see issue of April 20, 1934). A higher-power range of this make is now available for railway purposes, and the accompanying illustration shows a seven-cylinder 350 b.h.p. unit.

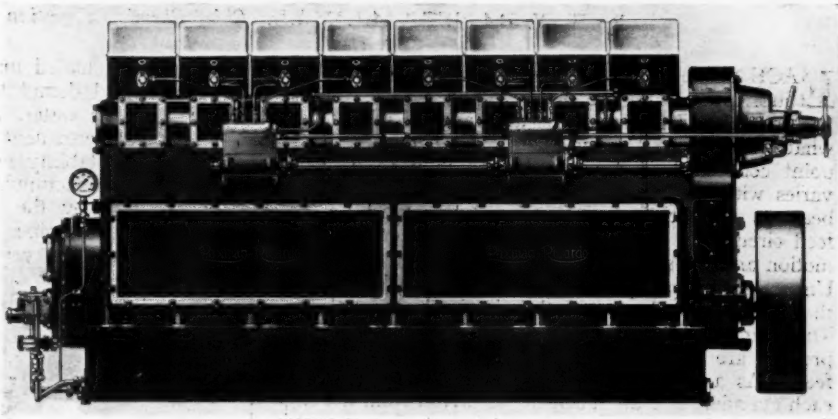


Seven-cylinder 350 b.h.p. Brotherhood-Ricardo engine

These larger engines incorporate the usual Brotherhood feature of sleeve valves, which eliminates inlet and exhaust valves, valve springs, and the rockers and their operating gear. The admission of air and discharge of exhaust gases from each cylinder are controlled by a single cast-iron ported sleeve having a compound rotary motion with vertical and horizontal components. Special provision is made for cooling the exhaust ports, and the inlet ports are arranged tangentially so as to give the air charge a rotational swirl. Each of the 7½ in. by 12 in. cylinders is a separate iron casting, and 50 b.h.p. is developed in each at a speed of 900 r.p.m. The cylinder heads are solid steel forgings machined all over; the lower part of the head forms the combustion space which is not on Ricardo's usual spherical air-cell principle but simply a cylindrical neck of smaller diameter than the cylinder. Fuel injection is on the C.A.V.-Bosch principle, and the pump is in one unit, mounted midway along the engine length. A vertical-shaft governor is fitted on top of the crankcase.

A NEW BRITISH HEAVY-OIL ENGINE DESIGN

Four-stroke unit with Ricardo head is now available for traction work



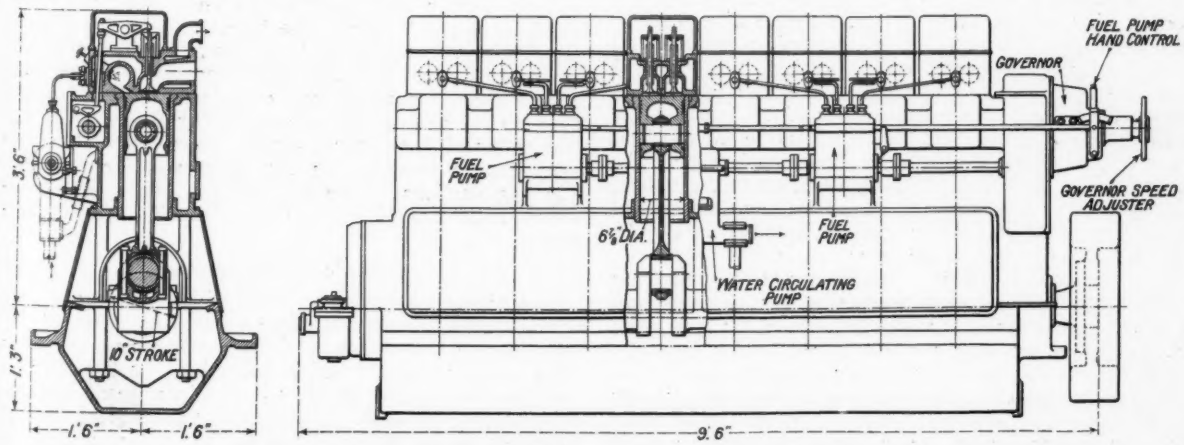
Fuel-pump side of Paxman-Ricardo 330 b.h.p. engine

THE Paxman oil engine installed in the last of the Hunslet-built diesel-mechanical shunting locomotives of the L.M.S.R. was of the direct airless injection type, and an illustrated description of it will be found in the issue of this Supplement for November 30, 1934. Davey Paxman & Co. (Colchester) Ltd., has taken up the manufacture of engines fitted with Ricardo's Comet head, the feature of which is the spherical air cell, as shown in the sectional arrangement at the bottom of this page.

Compared with the engine in the L.M.S.R. shunter, one of the main points of difference is that the bedplate and crankcase are normally of cast iron instead of being built up of welded steel on the Stevens' principle. However, these engines can be built with welded frames if desired.

A large range of Paxman-Ricardo engines is now being made, but for railway purposes the most interesting models are those ranging from 225 to 300 b.h.p. The engine illustrated on this page can develop a continuous output of 300 b.h.p. at 1,000 r.p.m. in eight cylinders having a bore of $6\frac{7}{8}$ in. and a stroke of 10 in. This rating corresponds to a piston speed of 1,660 ft. per min. and a brake m.e.p. of 80 lb. per sq. in., but for traction work, where the load is generally of an intermittent character, the maker's rating for the eight-cylinder engine is 338 b.h.p., at 1,000 r.p.m., corresponding to a brake m.e.p. of 90 lb. per sq. in. The weight of the engine is 4·65 tons, corresponding to 31 lb. per b.h.p. on the traction rating, and to suit railway work it is designed to operate at fixed or variable speed.

Another feature of the engine is that in conjunction with an exceptionally rigid main construction, light reciprocating and revolving parts are used. The pistons are of heat-treated light alloy with fully-floating gudgeon-pins of casehardened steel, and the connecting rods are of H-section high-grade steel. The cylinder heads are cast of special steel and are of such design as to allow of free circulation of the cooling water. Two silichrome valves per cylinder are fitted, and are actuated by short push rods from a camshaft situated in a chamber forming part of the cylinder block. The removal of light cover plates enables the camshaft to be inspected with the greatest ease. Fuel is injected by a Paxman pump which is in two sections for the eight-cylinder design, and is driven from the flywheel end of the engine. The governor is of the centrifugal spring-loaded type and is totally enclosed. A pressure-lubrication system is incorporated, and the main pump is of the valveless gear-driven type with rotors forged solid on their shafts. Full consideration was given in the designing stage to the requirements of traction service, and three-point suspension and different positions of the circulating pumps, &c., are feasible.



Arrangement of 300-330 b.h.p. Paxman-Ricardo engine

THE LUBRICATION OF DIESEL ENGINES

By H. N. BASSETT, A.I.Mech.E., Chief Chemist, Egyptian State Railways

EACH prime mover has its own particular problems in lubrication, and the diesel engine is no exception to the rule. The methods of applying the oil vary somewhat with the design and size of the engine, and of the point concerned, and naturally the kind of oil selected varies with the use to which it is to be put. The main bearings of most diesel engines are lubricated by a forced-feed circulating system, in which the oil is constantly in motion and the supply to the bearings is always adequate. Unless the oil pump breaks down or a leak develops in the system and oil escapes, the film is always maintained. The cylinders, both of the power unit and of the air compressor, are generally lubricated mechanically with forced feed. As a rule there are from two to four oil pipes to each cylinder, and the lubricator is driven from the engine. Timing of the delivery of the oil is not always provided for, though it is desirable in order that correct distribution of the oil over the surface of the cylinder may be effected.

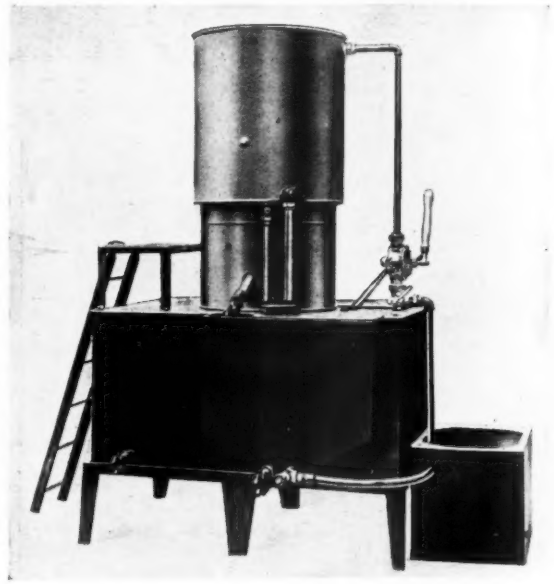
In some types of single acting engines the cylinder gets its oil by throw from the crankshaft, but this method has sundry disadvantages, not the least of which is that very little oil reaches the cylinder until the engine has got up speed, whereas it is in the early stages of running that oil is most badly needed. The main bearings are sometimes ring-oiled, the rings dipping into wells in the bearing housings, and carrying oil up on to the journals on which the rings revolve. This is satisfactory so long as the oil is watched and changed in the wells before it has time to become sticky. Crankpin bearings may receive their oil from a mechanical oiler feeding into a banjo oiler delivering its oil through holes drilled near the periphery. Although in some cases the cylinder is lubricated by oil thrown off by the crankshaft bearing, as has been mentioned earlier, and therefore one oil serves for both cylinder and bearing, this is not so in all cases, and oils of different characteristics are required for the two purposes.

Bearing Lubrication

When the engine is at rest the journal is resting on and is probably in contact with the bearing surface. As soon as rotation begins the journal tends to lift, and presently a wedge of oil separates the surfaces completely. When the motion is very slow at first the pressure tends to squeeze out the oil and to break the film, and the resistance which the oil offers to this tendency is a measure of its quality and suitability. There are other factors of importance, and in particular the pressure on the bearing during normal operation per sq. in. of normal bearing area (this is not always the same as the *projected* area of the bearing), the speed of the journal, and the temperature at which it usually operates have to be taken into consideration. The method of application also has some bearing on the matter, and generally speaking with a circulatory forced feed lubrication system a lighter (lower viscosity) oil can be used more safely than under other conditions.

In a circulating system oil is present in the crankcase in the form of an exceedingly fine mist, and consequently is under conditions extremely favourable for oxidation, especially if water vapour is also present. It is desirable, therefore, that an oil intended for a circulatory system should be as stable towards oxidation as possible. In view of the possibility also of contamination of the oil by water from the cooling system (which sometimes develops leaks) and of the damage which results if an emulsion of oil and water is circulated instead of oil, the oil selected should have a good demulsibility factor, *i.e.*, it should separate quickly from water, with the formation of the minimum amount of permanent emulsion.

Lack of stability in the oil makes itself felt sooner or later by the accumulation of sludge in the oil tank, and occasionally by the precipitation of sludge and foreign matter in the pipes of the circulatory system. Such deposits may be very serious indeed, though if a continuously-operated centrifugal machine is attached to the engine the sludge will be removed as soon as it is formed, and will never be present in the oil in amount sufficient to cause troublesome deposits.



Fox cleaning plant for lubricating oil

It should not be forgotten that if the oil is too light it will not always maintain the film under pressure, which will lead to rapid wear in the bearings. Too light an oil also tends to escape from the system, especially from the bearings, causing excessive oil consumption; too heavy an oil, on the other hand, means an increase in the power used up in the bearings in overcoming the internal friction of the oil, and it is necessary therefore to strike the happy mean between the too-heavy and the too-light. The specifications at the end of this article are of oils which have proved suitable for the different purposes shown.

Cylinder Lubrication

The oil used in the lubrication of the cylinders has a dual purpose to perform, for not only has it actually to lubricate (to prevent metallic contact between the piston rings and the cylinder walls), but it has also to act as an effective seal to prevent blow back of the gases past the piston rings. A leaky piston seal makes a great deal of difference to the power output of the engine, and whilst the rings afford the principal seal they are greatly assisted

by a suitable oil. There are sundry factors which must be taken into account in selecting a cylinder lubricant, apart from the elementary one which has just been mentioned, which depends upon the viscosity of the oil, and among these are the way and the extent to which the piston is cooled, the size of the cylinder, and the resistance of the oil to oxidation and the tendency to form deposits.

The film of oil on the cylinder walls is extremely thin, and is exposed directly to the burning gases every stroke in a two-stroke engine and every second stroke in a four-stroke engine. The maximum temperature of the burning gases is probably in the neighbourhood of 2,700° F., and no oil exists which will not burn away at this temperature. The average temperature during a complete cycle, however, is probably about 950° F., which is the temperature of the gases, and not of the cylinder walls. It is practically impossible to obtain the actual temperature of the walls, but it is probable that it does not exceed 250° F. very much. This being the case, the high temperature of the gases need cause no concern, for the oil film on the walls is exposed to them for a very small fraction of a second, and there is no time for the film to burn before it is renewed again. An oil with a flash point above 300° F. would probably prove satisfactory, though most diesel cylinder oils have flash points considerably higher than this. Effective cooling is necessary, however, especially of the piston in large engines, because otherwise trouble is likely to arise from the formation of carbon deposits on the piston head, and the rings also may get stuck in their grooves so that blow back of the gases takes place with consequent loss of power.

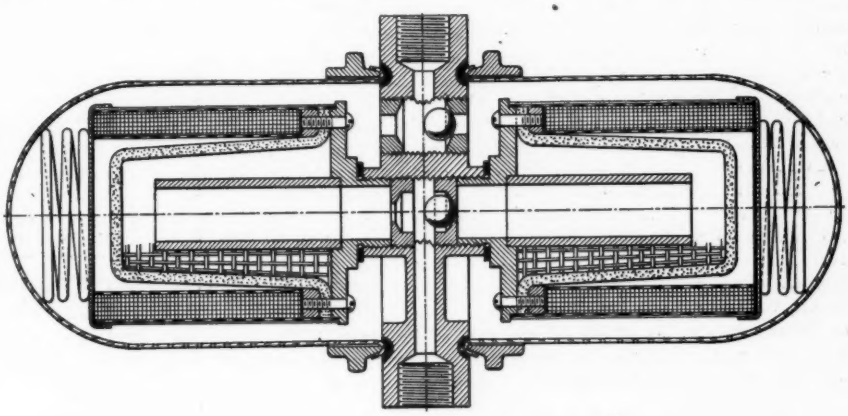
A rather more viscous oil is required with large cylinders than with small, but the use of a heavy oil is sometimes the cause of excessive carbon deposits being formed. Such a case was examined some years ago in which a plant comprising five two-stroke land-type diesels running at 300 r.p.m. and of 520 b.h.p. each was concerned. At the end of the first six months of operation just over 8 per cent. of the available running time had been lost by mechanical troubles, and nearly 90 per cent. of this time was lost because of faulty lubrication. The oil in use was of mid-Continent origin and had a viscosity (Saybolt) of 82 sec. at 210° F. and the consumption was one gallon per 757 horsepower hours. The carbon deposit was very heavy, and tests were made with oils of lower viscosity, until one was found which had a viscosity (Saybolt) of only 56 sec. at 210° F. This also had a much lower flashpoint than the oil formerly used. With the new oil the consumption was one gallon per 1,241 horsepower hours, and the temperature of the cooling water leaving the jacket was 123° F. as compared with 179° F. with the heavier oil. More important still was the fact that when dismantled at the end of 30 days the engine was in excellent condition, indicating that the lubrication had been almost perfect. The trouble with carbon formation ceased when the new oil was put into general use. This experience leads one to conclude that there is much to be said for the use of a cylinder oil as low in viscosity as possible.

Lubricating Oil and Failures

It will be understood that there are some things, such as excessive wear of liners and piston rings, which depend more upon the fuel than upon the lubricating oil and its quality and quantity, but there are other matters, such as the consumption, bearing temperatures, and the formation of carbon deposits in the engine and of deposits in the circulating system, which may be connected up with oil.

In bearings the consumption will depend to a considerable extent upon the viscosity, and, other things being equal, a more viscous oil will give a lower consumption than one less viscous. With the lighter oil, however, the internal friction will be less and the bearing will run cooler. In a circulatory system the oil is exposed to oxidation, and hence stability is an important factor, and in view of the possibility of leaking of water from cylinder jackets, demulsibility is also important. An oil which forms sludge readily when tested by the standard method (which is actually oxidation of the oil in the presence of a catalyst in the shape of copper foil), and which readily emulsifies and remains emulsified after standing, will prove to have a high consumption, because it will be necessary to change it sooner than if it were more resistant to oxidation and emulsification. There is a danger also of deposits forming in the oil pipes unless a continuously-operated cleaning plant extracts oil from the tank for cleaning during the whole of the time the engine runs, returning it after removal of the sludge and water. It is worth while, therefore, to buy a high quality oil, for not only will the consumption be less, but there will be less doubt about the satisfactory nature of the lubricant.

Dilution of the oil in the crankcase may or may not present a difficulty, as not all diesel engines cause dilution. When it does take place nothing approaching an equilibrium point is ever reached as with automobile engine crankcase oils. This is because the fuel used in a diesel engine has a much higher boiling range than motor spirit, and no part of the fuel which dilutes the oil in the crankcase is distilled off at the temperature obtaining there. Consequently it is necessary sooner or later to remove the whole of the oil and replace it by new. The change becomes desirable sooner or later in any event, irrespective of dilution, because of the gradual accumulation of finely



The Vokes triple reversible filter for fuel and lubricating oils. The first and second stages of the filter are arranged for easy withdrawal, and by doing much of the filtering they prevent the frequent clogging of the third (and most efficient) stage

divided carbon in the oil, which assists in the formation of deposits and the stabilisation of emulsions.

Where the same oil is used for cooling the pistons as is used for the bearings it is important that the oil shall be as stable as possible, or the formation of deposits in the cooling spaces in the heads will lead to ineffective cooling, which in its turn will cause formation of carbon on the top of the piston from the lubricant and fuel.

Carbon Deposits

A most potent cause of carbon formation in the cylinders is over-oiling, and sometimes if the oil supply is cut down the trouble from deposits vanishes at the same time. The insistence of engineers on a high flash point is responsible often for trouble in this direction, because to obtain it a high fire test oil has to be used as a base, which means that during the brief time that the oil is exposed to the flame in the cylinder a part of it only distils off, the remainder staying behind as a more or less sticky residue. As the temperature of the cylinder walls probably is in the neighbourhood of 250° F., therefore there is no necessity to ask for an oil with a flashpoint in excess of 400° F. The flashpoint is the temperature at which the oil, when tested under certain specified conditions, begins to give off inflammable vapours. It is not the boiling point by any means, and to insist on a very high flashpoint means that the boiling point is higher still, and consequently such an oil cannot distil off readily from the cylinder walls.

Examination of carbon deposits shows that as a rule they consist chiefly of iron which is derived from wear of the cylinders and rings, with a greater or less proportion of oil and a proportion, usually several per cent., of hard asphalt. This comes from the oil, and is the product of oxidation and polymerisation of the constituents of the oil. For this reason it is usual to specify a low initial content of asphalt in the oil. At the same time absence of asphalt in new oil does not mean that none can, or will be formed during use, and experiments which the author has made showed conclusively that an oil originally free from hard asphalt can develop it in considerable amount when heated in contact with air for a lengthy period. Under the conditions obtaining in a diesel cylinder the oxidation and polymerisation takes place very much more quickly. It is a reasonable precaution to take, therefore, to start off with the least possible amount in the new oil, the more so as the asphaltic bodies have a higher coefficient of friction than the oil, and so tend to increase liner and ring wear.

The effect of carbon deposition is usually first of all to fix the rings solidly in their grooves. As the effectiveness of the oil seal depends to some extent upon the elasticity of the ring it loses a great deal when the ring can no longer move freely in its groove, and loss of power is the result. This necessitates more frequent dismantling of the engine for attention to the rings.

Sundry laboratory tests have been developed which claim to show the tendency of an oil to form carbon deposits, but generally speaking the conditions of test bear no resemblance to the conditions under which the oil works in service, and there is considerable doubt as to whether the results obtained are very valuable. A more reliable guide can be obtained, probably, from the viscosity and the hard asphalt content, taken into consideration with the flashpoint. A high viscosity, high flashpoint oil, whether containing hard asphalt or not, will usually form more carbon than one of relatively low viscosity and lower flashpoint, even when it contains some hard asphalt.

It has been suggested that when rings have become sticky because of carbon formation a proportion of kerosene should be added to the oil. Presumably this is to soften the deposits and free the rings, on the assumption that what happens when the engine is dismantled will happen also when it is running. This is by no means certain to be the case, however, and it is much more likely to have no effect at all. The kerosene would volatilise as soon as it entered the cylinder (practically the whole of it boils below 400° F., and the mean temperature of the gases is probably about 950° F.), and in its highly inflammable condition would have little time to act upon the gummy matter in the ring grooves.

Some specifications for diesel engine oil include the cold test. This is not very important, so long as the oil is not too viscous at ordinary temperatures as to require heating for application. Although there is considerable pressure behind the oil it is better, and uses less power, if the oil can be injected easily. It will also spread more quickly and more evenly over the cylinder wall.

In Tables I and II are given the physical characteristics of oils suitable for the purposes shown. It is not suggested that no oils which failed to conform with the properties shown would be satisfactory, but experience has indicated that oils of the nature shown will give satisfaction.

TABLE I.—TYPES OF OIL FOR VARIOUS PURPOSES (TO BE USED IN CONJUNCTION WITH TABLE II)

Type of Oiling System		B.H.P. per Cylinder	Cylinders	Bearings
Cylinders	Bearings			
Mechanical forced feed	Circulation	Below 150	No. 1	No. 4
		150—350	No. 2	No. 1
		Over 350	No. 3	No. 1
Mechanical forced feed	Mechanical forced feed	Below 150	No. 1	No. 1
Mechanical forced feed	Ring oiled	Below 150	No. 1	No. 1
Oil throw only ..	Circulation	Below 150	No. 1	No. 1
		150—350	No. 1	No. 1
From circulating system	Circulation	Below 150	No. 1	No. 1
		150—350	No. 1	No. 1

TABLE II.—PHYSICAL CHARACTERISTICS OF LUBRICATING OILS

Oil number	1	2	3	4
Specific gravity at 60° F.	0·895	0·905	0·895	0·905
Flash point, closed test	425° F.	430° F.	465° F.	385° F.
Cold test	Below 40° F.	Below 40° F.	Below 40° F.	Below 35° F.
Viscosity, Redwood :				
100° F.	500 sec.	826 sec.	1,310 sec.	229 sec.
140° F.	175 sec.	267 sec.	398 sec.	94 sec.
210° F.	58 sec.	74 sec.	102 sec.	44 sec.
Hard asphalt	Nil	Nil	Nil	Nil
Compounding agent	Nil	Nil	Nil	Nil

In cases where the temperature of the oil in the bearing system is very high (either because of piston cooling or because the engine is working under tropical conditions) a heavier oil than No. 4 may be required, in which case No. 1 may be used. The figures given in Table II are those obtained by normal laboratory examination of samples, and obviously can be offered only as an indication of the characteristics of suitable oils. If they are taken as the basis of specifications it will be necessary to allow some latitude, especially in the viscosity and specific gravity. The latter property is of no importance at all from the point of view of lubrication, and merely offers some sort of an indication as to the source of the oil. All the oils for which figures are given in Table II are of American origin, but oils coming from other sources with different characteristics may be satisfactory also.

The cleaning of oils during use has been mentioned. It is undoubtedly worth while, as the oil is kept in good condition, and wear in the bearings is reduced. A case has been reported of a ferry boat engine on which it was necessary to take up the connecting rod bearings 0·012 in. every fortnight. When a centrifugal oil cleaner was installed, and operated continuously, the wear was 0·001 in. on seven rods and 0·003 in. on seventeen in five months.